XII

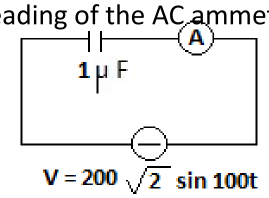
FOUNDATION PHYSICS

CONTENTS

Alternating Current

PHYSICS

1. In the circuit shown in figure, the reading of the AC ammeter is



(a) $20\sqrt{2}$ mA
(b) $40\sqrt{2}$ mA
(c) 20 mA
(d) 40 mA

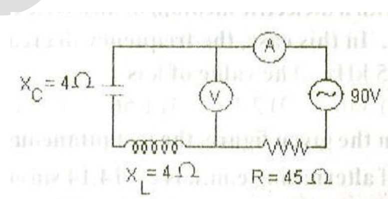
2. When an alternating voltage of 220 V is applied across a device P, a current of 0.25 A flows through the circuit and it leads the applied voltage by an angle $\pi/2$ radian. When the same voltage source is connected across another device Q, the same current is observed in the circuit but in phase with the applied voltage. The current when the same source is connected across a series combination of P and Q is

(a) $\frac{1}{4\sqrt{2}}$ A lagging in phase by $\pi/4$ with voltage
(b) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\pi/4$ with voltage
(c) $\frac{1}{\sqrt{2}}$ A leading in phase by $\pi/4$ with voltage
(d) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\pi/2$ with voltage

3. In a series LCR circuit, current in the circuit is 11 A when the applied voltage is 220 V. Voltage across the capacitor is 200 V. If value of resistor is 20 Ω, then the voltage across the known inductor is

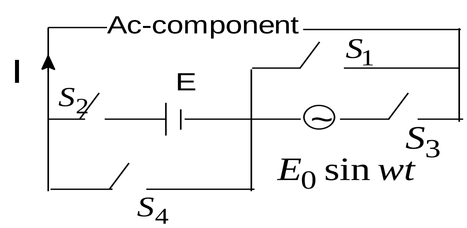
(a) Zero (b) 200 V (c) 20 V (d) 10V

4. The reading of voltmeter and ammeter in the following figure will respectively be



(a) 0 and 2A (b) 2A and 0V
(c) 2V and 2A (d) 0V and 0A

5. In the given circuit if switches S_3 and S_4 are open, keeping S_1 and S_2 closed, the value of I is I_0. If switches S_1 and S_2 are open, keeping S_3 and S_4 closed, the value of I is I_0sinwt. Now, if switches S_1 and S_4 are open keeping S_2 and S_3 closed, the value of rms current through the AC - component, during one complete cycle is



(A) $I_0\left(1+\frac{1}{\sqrt{2}}\right)$ (B) $\frac{I_0}{\sqrt{2}}$
(C) $I_0\left(1-\frac{1}{\sqrt{2}}\right)$ (D) $\sqrt{\frac{3}{2}}I_0$

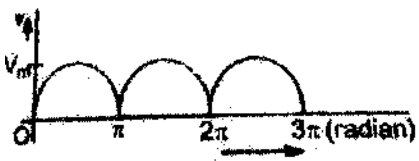
6. A solenoid with inductance L =7mH and active resistance 44 Ω is first connected to a source of direct voltage V_0 and then to a source of sinusoidal voltage with effective value $V=V_0$. The frequency of oscillator when the power consumed by the solenoid be 5 times less than former case is

a) 3.5kHz b) 20kHz c) 25kHz d) 2 kHz

7. An alternating current I is given by $I = I_0 \sin 2\pi\left(\frac{t}{T}+\frac{1}{4}\right)$. Then the average current in the first one quarter of time period is

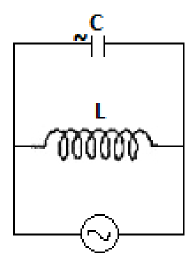
a) $\frac{2I_0}{\pi}$ b) $\frac{I_0}{\pi}$ c) $\frac{I_0}{2\pi}$ d) $\frac{3I_0}{\pi}$

8. The average and effective values for the wave shape (in the form of a sinusoidal curve) shown in the figure are



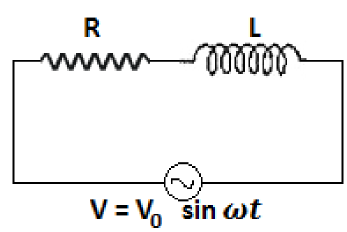
(a) $\frac{2}{\pi}V_m, \frac{V_m}{2}$ b) $\frac{V_m}{\pi}, \frac{V_m}{\sqrt{2}}$ c) $\frac{2}{\pi}V_m, \frac{V_m}{\sqrt{2}}$ d) $\frac{V_m}{\pi\sqrt{2}}, \frac{V_m}{\sqrt{2}}$

9. In the AC network shown in figure, the rms current flowing through the inductor and capacitor are 0.6 A and 0.8 A respectively. Then the current coming out of the source is



(a) 1. 0 A
(b) 1.4 A
(c) 0.2 A
(d) zero

10. In the circuit shown in figure, the energy lost in one cycle is



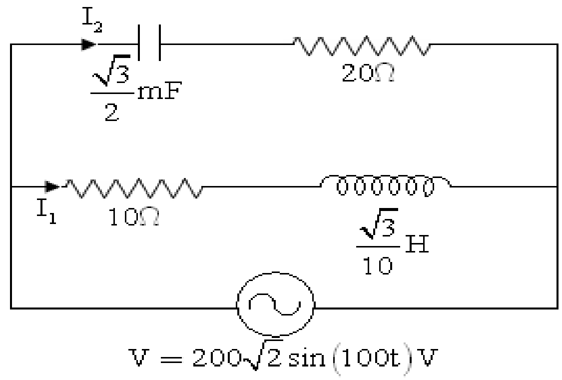
(a) zero (b) $\frac{V_0^2}{2R}$

(c) $\frac{V_0^2 R}{2(R^2+\omega^2L^2)}$ (d) $\frac{V_0^2}{R}$

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	b	b	a	d	d	a	c	c	c

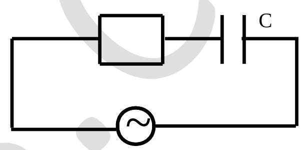
1. In the circuit



1) I_2 leads I_1 by $\frac{\pi}{2}$ 2) I_1 leads I_2 by $\frac{\pi}{2}$

3) Phase difference b/n I_1 and I_2 is 4) Phase difference b/n I_1 and I_2 is 0

2. In the circuit shown, there is a box and a capacitance C connected to alternating power source of angular frequency 2 rad/s. Box has a power factor of $1/\sqrt{2}$ and the circuit has a overall power factor 1. The impedance of the box is



a) $\frac{1}{C}$ b) $\frac{1}{C\sqrt{2}}$ c) $\frac{\sqrt{2}}{C}$ d) $\frac{1}{C\sqrt{3}}$

3. An a.c. source of voltage V and of frequency 50 Hz is connected to an inductor of 2H and negligible resistance. A current of r.m.s. value I flows in the coil. When the frequency of the voltage is changed to 400 Hz keeping the magnitude of V the same, the current is now

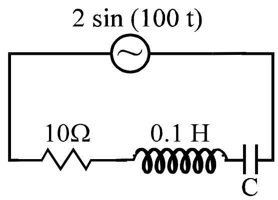
a) 8I in phase with V b) 4I and leading by 90° from V

c) I/4 and lagging by 90° from V d) I/8 and lagging by 90° from V

4. A series RC combination is connected to an ac voltage of angular frequency ω=500rad/s. If the impedance of the RC circuit is R $\sqrt{1.25}\ \Omega$, the time constant (RC) (in ms) of the circuit is

a) 1 b) 2 c) 3 d) 4

5. The power factor of the circuit is $1/\sqrt{2}$. The capacitance of the circuit is equal to

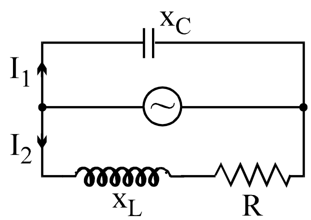


a) 400μF b) 300μF c) 500 μF d) 200 μF

6. A coil has an inductance of $11/5\,\pi$ H and is joined in series with a resistance of $220\,\Omega$. When an alternating emf of 220 V at 50 cps is applied to it, the wattles component of the current in the circuit is

a)5 A b) 0.7 A c) 0.5 A d) 7 A

7. In the AC circuit shown, phase difference between currents I_1 and I_2 is



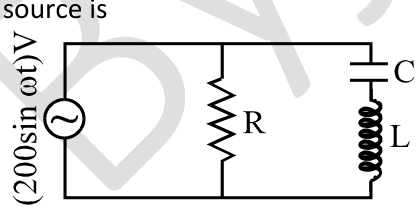
a) $\frac{\pi}{2} - \tan^{-1}\frac{X_L}{R}$ b) $\tan^{-1}\frac{X_L - X_C}{R}$

c) $\frac{\pi}{2} + \tan^{-1}\frac{X_L}{R}$ d) $\tan^{-1}\frac{X_L - X_C}{R} + \frac{\pi}{2}$

8. In an oscillating LC circuit in which C =4μF the maximum potential difference across the capacitor during the oscillation is 1.5V and the maximum current through the inductor is 50mA. The inductance of the coil is

a) 3.6 mH b) 4.8mH c) 1.2mH d) 9.6mH

9. In the circuit diagram shown, $X_C = 100\Omega$, $X_L = 200\ \Omega$ and $R = 100\ \Omega$. The effective current through the source is



a) 2A b) $\sqrt{2}$A c) 0.5A d) $2\sqrt{2}$A

10. An LCR series circuit with 100 ohms resistance is connected to an ac source of 200V and angular frequency 300 rad/s. When only the capacitance is removed, the current lags behind the voltage by 60^0. When only the inductance is removed, the current leads the voltage by 60^0. The current in the LCR circuit is

a) 1A b) 2A c) 3A d) 4A

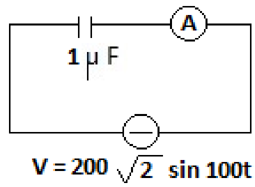
Answer Key

1	2	3	4	5	6	7	8	9	10
a	b	d	d	c	c	c	a	a	b

1. In an AC circuit, the impedance is $\sqrt{3}$ times the reactance, then the phase angle is
(a) 60° (b) 30° (c) $\cos^{-1}(\sqrt{3})$ (d) $1/\cos^{-1}(\sqrt{3})$

2. In a purely resistive AC circuit
(a) voltage leads current (b) voltage lags current
(c) voltage and current are in same phase (d) nothing can be said

3. In the circuit shown in figure, the reading of the AC ammeter is
(a) $20\sqrt{2}$ mA
(b) $40\sqrt{2}$ mA
(c) 20 mA
(d) 40 mA



4. An AC voltage is applied across a series combination of L and R. If the voltage drop across the resistor and inductor are 20 V and 15 V respectively, then applied peak voltage is
(a) 25 V (b) 35 V (c) $25\sqrt{2}$ V (d) $5\sqrt{7}$ V

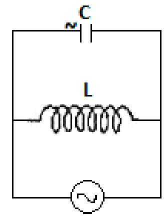
5. When 100 volt DC source is applied across a coil, a current of 1 A flows through it. When 100 V AC source of 50 Hz is applied to the same coil, only 0.5 current flows. Calculate the inductance of the coil
(a) $(\pi/\sqrt{3})$H (b) $(\sqrt{3}/\pi)$H (c) $(2/\pi)$H (d) $\sqrt{3}$ H

6. A complex current wave is given by i = (5 + 5 sin 100ωt) A. Its average value over one time period is given as
(a) 10 A (b) 5A (c) $\sqrt{50}$A (d) 0

7. When an alternating voltage of 220 V is applied across a device P, a current of 0.25 A flows through the circuit and it leads the applied voltage by an angle $\pi/2$ radian. When the same voltage source is connected across another device Q, the same current is observed in the circuit but in phase with the applied voltage. The current when the same source is connected across a series combination of P and Q is
(a) $\frac{1}{4\sqrt{2}}$ A lagging in phase by $\pi/4$ with voltage (b) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\pi/4$ with voltage
(c) $\frac{1}{\sqrt{2}}$ A leading in phase by $\pi/4$ with voltage (d) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\pi/2$ with voltage

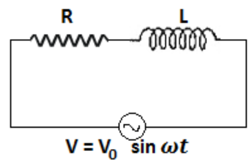
8. In a series LCR circuit, current in the circuit is 11 A when the applied voltage is 220 V. Voltage across the capacitor is 200 V. If value of resistor is 20 Ω, then the voltage across the known inductor is
(a) Zero (b) 200 V (c) 20 V (d) 10V

9. In the AC network shown in figure, the rms current flowing through the inductor and capacitor are 0.6 A and 0.8 A respectively. Then the current coming out of the source is



(a) 1. 0 A
(b) 1.4 A
(c) 0.2 A
(d) zero

10. In the circuit shown in figure, the energy lost in one cycle is



(a) zero
(b) $\frac{V_0^2}{2R}$
(c) $\frac{V_0^2\,R}{2\,(R^2+\omega^2L^2)}$
(d) $\frac{V_0^2}{R}$

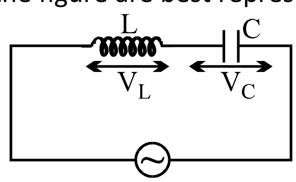
ANSWER KEY

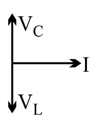
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
d	c	c	c	b	b	b	b	c	c

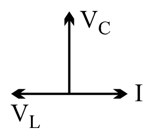
1. In a transformer the output current and voltage are respectively 4 A and 20 V. If the ratio of number of turns in the primary to secondary is 2 : 1. The input current and voltage is
(a) 2 A and 40 V (b) 8 A and 10 V (c) 4 A and 10 V (d) 8 A and 40 V

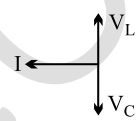
2. A transformer is used to light a 140 W, 24 V bulb from a 240 V ac mains. The current in the main cable is 0.7 A. The efficiency of the transformer is
a) 63.9% b) 83.3% c) 16.7% d) 36.2%

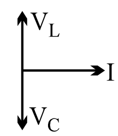
3. The current I, potential difference V_L across the inductor and potential difference V_C across the capacitor in circuit as shown in the figure are best represented vectorally as



a) 

b) 

c) 

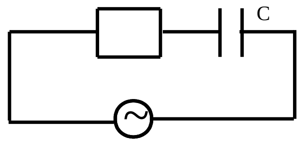
d) 

4. The equation of an alternating voltage is $E=220 \sin(\omega t+\pi/6)$ and the equation of the current in the circuit is $I=10 \sin(\omega t- \pi/6)$. Then the impedance of the circuit is
(a) 10 ohm (b) 22 ohm (c) 11 ohm (d) 17ohm

5. An a.c. source of voltage V and of frequency 50 Hz is connected to an inductor of 2H and negligible resistance. A current of r.m.s. value I flows in the coil. When the frequency of the voltage is changed to 400 Hz keeping the magnitude of V the same, the current is now
a) 8I in phase with V b) 4I and leading by 90° from V
c) I/4 and lagging by 90° from V d) I/8 and lagging by 90° from V

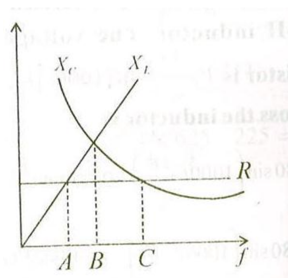
6. An LCR series circuit with 100 ohms resistance is connected to an ac source of 200V and angular frequency 300 rad/s. When only the capacitance is removed, the current lags behind the voltage by 60^0. When only the inductance is removed, the current leads the voltage by 60^0. The current in the LCR circuit is
a) 1A b) 2A c) 3A d) 4A

7. In the circuit shown, there is a box and a capacitance C connected to alternating power source of angular frequency 2 rad/s. Box has a power factor of $1/\sqrt{2}$ and the circuit has a overall power factor 1. The impedance of the box is



a) $\frac{1}{C}$ b) $\frac{1}{C\sqrt{2}}$ c) $\frac{\sqrt{2}}{C}$ d) $\frac{1}{C\sqrt{3}}$

8. The figure shows variation of R, X_L and X_C with frequency f in a series L, C, R circuit. Then for what frequency point, the circuit is inductive



(a) A (b) B (c) C (d) All points

9. A 220V, 50Hz a.c. generator is connected to an inductor and a 50Ω resistance in series. The current in the circuit is 1.0A. The P.D. across inductor is
(a) 102.2V (b) 186.4V (c) 213.6V (d) 302V

10. In an oscillating LC circuit in which C =4μF the maximum potential difference across the capacitor during the oscillation is 1.5V and the maximum current through the inductor is 50mA. The inductance of the coil is
a) 3.6 mH b) 4.8mH c) 1.2mH d) 9.6mH

Answer Key

1	2	3	4	5	6	7	8	9	10
a	b	d	b	d	b	b	c	c	a

Atoms

PHYSICS

1. The linear momentum of an electron, initially at rest, accelerated through a potential difference of 100 V is (in kg ms^{-1})
   (a) 2.25×10^{7} (b) 5.4×10^{-24} (c) 5.4×10^{7} (d) 2.85×10^{-24}
   Sol: (b)
   Here $\frac{p^2}{2m}$ = eV

   $\Rightarrow p = \sqrt{2meV}$
   $= \sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 100}$
   $= 5.4 \times 10^{-24}$

2. When a cathode ray tube is operated at 2912 V, the velocity of electrons is 3.2×10^{7} ms^{-1}, find the velocity of cathode ray, if tube is operated at 5824 V
   (a) 2.4×10^{7} ms^{-1} (b) 4.5×10^{7} ms^{-1} (c) 2.4×10^{5} ms^{-1} (d) 2.4×10^{8} ms^{-1}
   Here, $\frac{1}{2}mv^2 = eV$
   $\Rightarrow V = \sqrt{\frac{2eV}{m}}$
   $\Rightarrow v \propto \sqrt{V}$
   $\Rightarrow v_2 = v_1\sqrt{\frac{V_2}{V_1}}$
   $= 3.2 \times 10^{7}\sqrt{\frac{5824}{2912}}$
   $= 4.5 \times 10^{7}$ ms^{-1}

3. An α – particle and a proton are accelerated from rest by a potential difference of 100 V. After this, their de-Broglie wavelengths are λ_α and λ_p respectively. Then the ratio of $\left(\frac{\lambda_p}{\lambda_e}\right)$ is
   (a) 2 (b) $2\sqrt{2}$ (c) $\frac{1}{2}$ (d) $\frac{1}{2\sqrt{2}}$
   Sol: (b)
   $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2qmV}}$
   $\Rightarrow \lambda \propto \frac{1}{\sqrt{qm}}$
   $\Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{q_\alpha}{q_p} \cdot \frac{m_\alpha}{m_p}} = \sqrt{\frac{2q}{q} \times \frac{4m}{m}} = \sqrt{8}$

4. Energy from the sun is received on earth at the rate of 2 cal/cm^2 min. If average wavelength of solar light be taken at 5500 Å then how many photons are received on the earth per cm^2 per min? ($h = 6.6 \times 10^{-34}$ Js, 1 cal = 4.2 J)
(a) 1.5×10^{13} (b) 2.9×10^{13} (c) 2.3×10^{19} (d) 1.75×10^{19}
Sol: (c)
Energy received from the sun
= 2 cal cm^{-2} $(min)^{-1}$
= 8.4 J cm^{-2} $(min)^{-1}$
$\therefore$ Energy of 1 photon received form sun,
$\Rightarrow E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{5500 \times 10^{-10}}$
$\Rightarrow E = 3.6 \times 10^{-19}$ J
$\therefore$ number of photons receiving the earth, per cm^2 per min are
$n = \frac{8.4}{3.6 \times 10^{-19}} = 2.3 \times 10^{19}$

5. A photon and an electron have equal energy E. Then the ration of wavelength of photon to that of electron is proportional to
(a) $\sqrt{E}$ (b) $\frac{1}{\sqrt{E}}$ (c) E (d) $\frac{1}{E}$
Sol: ()
Wavelength of photon $\lambda_p = \frac{hc}{E}$ . . . .(1)
Wavelength of electron $\lambda_e = \frac{h}{\sqrt{2mE}}$ . . . .(2)
$\Rightarrow \frac{\lambda p}{\lambda e} = \frac{hc}{E} \times \frac{\sqrt{2mE}}{h} = c\sqrt{\frac{2m}{E}}$

6. Electrons with de-Brogile wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-ray is
(a) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (b) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (c) $\lambda_0 = \frac{1}{2}$ (d)
Sol: (a)
Momentum of striking electrons $p = \frac{h}{\lambda}$
$\therefore$ kinetic energy of electrons $k = \frac{p^2}{2m} = \frac{h^2}{2m\lambda^2}$
The energy equal to maximum energy of X – ray photons
Therefore, $\frac{hc}{\lambda_0} = \frac{h^2}{2m\lambda^2}$
$\Rightarrow \lambda_0 = \frac{2m\lambda^2 c}{h}$

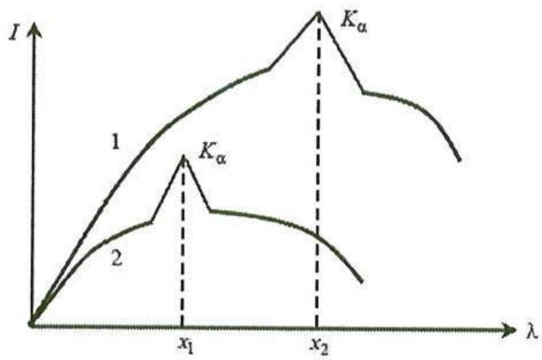
7. Mono chromatic light of wavelength 3000 Å is indecent on a surface area of 4 cm^2. If intensity of light is 150 mW m^{-2}, then the rate of which photons strike the target is
(a) $3 \times 10^{10} s^{-1}$ (b) $9 \times 10^{13} s^{-1}$ (c) $7 \times 10^{20} s^{-1}$ (d) $6 \times 10^{19} s^{-1}$
Sol: (b)
$\lambda = 3 \times 10^{-7}$ m, $A = 4 \times 10^{-4} m^2$, $I = 150 \times 10^{-3} W/m^2$
$\therefore\ I = \frac{E}{A \times t} = \frac{nhc}{\lambda \times At}$

$\Rightarrow \left(\frac{n}{t}\right) = \frac{I\lambda A}{hc} = \frac{150 \times 10^{-3} \times 3 \times 10^{-7} \times 4 \times 10^{-4}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$
$= 9 \times 10^{13} s^{-1}$

8. If a source of power 4 kW produces 10^{20} photon/second, the radiation belong to a part of the spectrum called, (h = 6.6×10^{-24} Js)
(a) X-rays (b) UV-rays (c) microwaves (d) γ-rays
Sol: (a)
power = $\frac{nhv}{t}$
p = $\left(\frac{n}{t}\right)$ hv
$\Rightarrow 4 \times 10^3 = 10^{20} \times 6.6 \times 10^{-34} \times v$
$\Rightarrow v = \frac{4 \times 10^3}{6.6 \times 10^{-14}} = 6 \times 10^{16}$ Hz.
The obtained frequency lies in the band of X-rays

9. K_α wavelength emitted by an atom of atomic number Z = 11 is λ. Find the atomic number for an atom that emits K_α radiation with wavelength 4λ.
(a) 4 (b) 5 (c) 6 (d) 7
Sol: (c)
$\frac{1}{\lambda} \propto (Z-1)^2$
Since hv_{k_α} eV $(z-1)^2 \left(\frac{1}{1^2} - \frac{1}{2^2}\right)$
$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{(z_2-1)^2}{(z_1-1)^2}$
$\Rightarrow \frac{\lambda}{4\lambda} = \left(\frac{z_2-1}{11-1}\right)^2$
$\Rightarrow \frac{10}{2} = z_2 - 1$
$\Rightarrow z_2 = 6$

10. When two different materials A and B having atomic number z_1 and z_2 are used as the target in Coolidge γ – ray tube at different operating voltage V_1 and V_2 respectively their sprectrums are found as below.



The correct relation is

(a) $V_1 > V_2, z_1 > z_2$ (b) $V_1 < V_2, z_1 < z_2$ (c) $V_1 < V_2, z_1 > z_2$ (d) $V_1 > V_2, z_1 < z_2$

Sol: (d)

Here $\lambda_{min} = \frac{hc}{eV}$

$\Rightarrow \lambda \propto \frac{1}{V}$

Since $\lambda_2 > \lambda_1$

$\Rightarrow V_1 > V_2$ . . . .(1)

We know that, $\sqrt{f}$ = a(z – b) mosley's law

$\Rightarrow \frac{1}{\lambda} \propto (z-1)^2$

$\Rightarrow \frac{1}{\lambda} \propto \frac{1}{(z-1)^2}$

∴ since $\lambda_2 > \lambda_1$

$\Rightarrow z_1 < z_2$ . . . .(2)

ANSWER KEYS

1	2	3	4	5	6	7	8	9	10
b	B	b	c		a	b	a	c	d

1. An electron, an α – particle and a proton have the same K.E. Which of these particles has the shortest, de-Broglie were length?
   (a) electron (b) proton (c) α – particle (d) electron, proton
   1. Sol: (c)
   $K_E = \frac{1}{2} mv^2 = \frac{p^2}{2m}$
   $p = \sqrt{2mE}$
   $\therefore \lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}}$
   $m_p = 1836m_e$
   $m_\alpha = 4 \times 1836m_e$
   $\therefore m_\alpha > m_p > m_e$
   $\Rightarrow \lambda_\alpha$ is the shortest

2. What is the ratio of de Brogile wavelength of deuteron moving with a velocity 2 v and α – particle moving with velocity v?
   (a) 1 : 1 (b) 1 : 2 (c) 1 : 4 (d) 4 : 1
   Sol: (a)
   $\lambda = \frac{h}{mv}$
   $\lambda_d = \frac{h}{2m_p \times 2v} = \frac{h}{4 \times m_p v}$ . . . .(1)
   $\lambda_\alpha = \frac{h}{4m_p \times v} = \frac{h}{4 \times m_p v}$ . . . .(2)
   From (1) and (2)
   $\lambda_d : \lambda_\alpha = 1 : 1$

3. A sodium lamp emits 3.14×10^{20} photons per second. Calculate the distance from the sodium lamp where flux of photon is one photon per second per cm^2.
   (a) 5 cm (b) 5×10^9 cm (c) 10 cm (d) 10^7 cm
   Sol: (b)
   Photon flux at a distance r
   $n = \frac{no.of\ photons\ emitted\ per\ sec}{4\pi r^2}$
   $\Rightarrow 1 = \frac{3.14 \times 10^{20}}{4 \times 3.14 \times r^2}$
   $\Rightarrow r^2 = \frac{10^{20}}{4} \Rightarrow r = 5 \times 10^9$ cm

4. If we consider electrons and photons of the same wavelength, then they will have the same
   (a) velocity (b) angular momentum (c) energy (d) momentum
   Sol: (d)
   For electron, $\lambda = \frac{h}{mv}$ . . . .(1)
   For photon, $\lambda = \frac{h}{(mc)}$ . . . .(2)
   $\therefore$ Both have same momentum

5. When a metallic surface is illuminated by a light of wavelength λ, the stopping potential for the photoelectric current is 3V, when the same surface is illuminated by light of wavelength 2λ, the stopping potential is 1 V. The threshold wavelength of this surface is
(a) λ (b) 2λ (c) 3λ (d) 4λ
Sol: (d)
For photo electric effect
$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + eV_1$
$\Rightarrow \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = 3\text{ eV}$ . . . .(1)
$\Rightarrow \frac{hc}{2\lambda} - \frac{hc}{\lambda_0} = \text{eV}$ . . . .(2)
$\therefore \frac{1}{\lambda} - \frac{1}{\lambda_0} = 3\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right)$
$\frac{3}{\lambda_0} - \frac{1}{\lambda_0} = \frac{3}{2\lambda} - \frac{1}{\lambda}$
$\frac{2}{\lambda_0} - \frac{1}{2\lambda} \Rightarrow \lambda_0 = 4\lambda$

6. Monochromatic light of wavelength 667 nm is produced by a laser lamp. The power emitted is 9 mW. The number of photons arriving per second on the average at a target irradiated by this beam is
(a) 3×10^{16} s^{-1} (b) 9×10^{15} s^{-1} (c) 3×10^{19} s^{-1} (d) 9×10^{17} s^{-1}
Energy of emitted photon,
$E = \frac{hc}{\lambda} = \frac{12400}{6670} = 1.86\text{ eV}$
Number of photons arriving per second on the target is
$= \frac{P}{E} = \frac{9 \times 10^{-3}}{1.86 \times 1.6 \times 10^{-19}} = 3 \times 10^{16}\text{ s}^{-1}$

7. In a photo electric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is
(a) 1.8 V (b) 1.3 V (c) 0.5 V (d) 2.3 V
Sol: (c)
If V_s is the stopping potential, then
Max. K.E. = $K_{max} = eV_s$
$\Rightarrow 0.5\text{eV} = eV_s$
$\Rightarrow V_s = 0.5$ V

8. Two identical, photo cathodes receives light of frequencies f_1 and f_2. If the velocities of the photo electrons (of mass m) coming out at respectively v_1 and v_2, then
(a) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$ (b) $v_1 + v_2 = \left(\frac{2h}{m}(f_1 + f_2)\right)^{\frac{1}{2}}$
(c) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 + f_2)$ (d) $v_1 - v_2 = \left(\frac{2h}{m}(f_1 - f_2)\right)^{\frac{1}{2}}$
Sol: (a)
$hf = hf_0 + \frac{1}{2}mv^2$
Here, $v_1^2 = \frac{2hf_1}{m} - \frac{2hf_2}{m} = v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

9. UV light of wavelength 300 nm and intensity $1Wm^{-2}$ falls on the surface of photo electric metal. If one percent of incident photons, produce photo electrons, then the number of photo electrons emitted from an area of $1.0\ cm^2$ of the surface is nearly

(a) $2.13 \times 10^{11}\ s^{-1}$ (b) $1.5 \times 10^{12}\ s^{-1}$ (c) $3.02 \times 10^{12}\ s^{-1}$ (d) None of these

Sol: (b)

$E = \frac{hc}{\lambda} = \frac{12400}{3000} = 4133$ eV

$= 6.6 \times 10^{-19}$ J

Power of source $P = I \times A = 1 \times 10^{-4} = 10^{-4}$ W

$\therefore$ No. of photons per second $= \frac{P}{E} = \frac{10^{-4}}{6.6 \times 10^{-19}}$

$\therefore$ No. of electrons $= \frac{1}{100} \times \frac{10^{-4}}{6.6 \times 10^{-19}} = 1.5 \times 10^{12}\ s^{-1}$

10. The energy of a photon is equal to the kinetic energy of a proton. The energy of the photon is E. Let λ_1 be the wavelength of the photon. The ratio of $\left(\frac{\lambda_1}{\lambda_2}\right)$ is proportional to

(a) E^0 (b) $E^{1/2}$ (c) E^{-1} (d) E^{-2}

Sol: (b)

$\frac{\lambda_1}{\lambda_2} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \sqrt{\frac{E}{2m}}\frac{1}{C}$

$\therefore \frac{\lambda_1}{\lambda_2} \propto E^{1/2}$

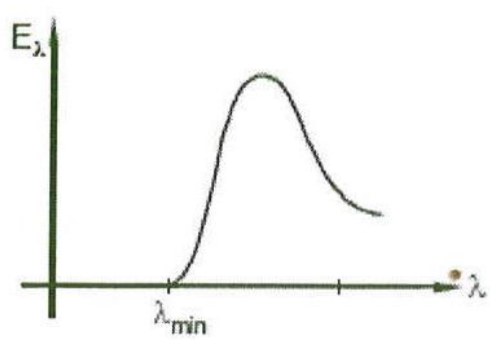
ANSWER KEYS

1	2	3	4	5	6	7	8	9	10
c	a	b	d	d	A	c	a	b	b

1. The K_α X-ray emission line of tungsten occurs at λ = 0.021 mm. The energy difference between K and L levels in this atoms is about:
   (a) 0.51 MeV (b) 1.2 MeV (c) 59 keV (d) 13.6 eV
   = 0.021 nm = 0.21 Å
   Since, λ_{k_α} corresponds to the transition of an electron from L-shell to K-shell, therefore
   $E_L - E_K$ = (in eV) = $\frac{12375}{\lambda\,(in\,\mathring{A})}$ = $\frac{12375}{0.21}$
   ≈ 58928 eV
   ΔE (in eV) = $\frac{12375}{1(in\,\mathring{A})}$ comes for E = $\frac{hc}{\lambda}$

2. As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom (Z = 3) is :
   (a) 1.51 (b) 13.6 (c) 40.8 (d) 122.4
   Sol: (d)
   For hydrogen and hydrogen like atoms
   $E_n = -13.6 \frac{(Z^2)}{(n^2)}$ eV
   Therefore, ground state energy of doubly ionized lithium atom (Z = 3, n = 1) will be
   $E_1 = (13.6) \frac{(3)^2}{(1)^2}$
   = – 122.4 eV
   ∴ Ionization energy of an electron in ground state of doubly ionized lithium atom will be 122.4 eV.

3. X-rays are produced in an X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-rays has values from
   (a) 0 to ∞ (b) λ_{min} to ∞ where $\lambda_{min} > 0$
   (c) 0 to λ_{max} where $\lambda_{min} < \infty$ (d) λ_{min} to λ_{max} where 0 $\lambda_{min} < \infty$
   Sol: ()
   The continuous X-ray spectrum is shown in figure.

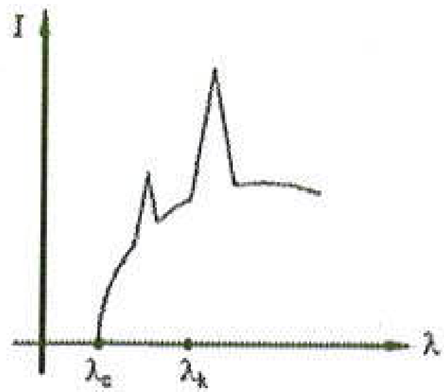


   All wavelengths > λ_{min} are found, where
   $\lambda_{min} = \frac{12375}{V(in\,volt)}$ Å
   Here, V is applied voltage.

4. In hydrogen spectrum the wavelength of H_α line in 656 nm; whereas in the spectrum of a distant galaxy H_α line wavelength is 706 nm. Estimated speed of galaxy with respect to earth is :
(a) 2×10^8 m/s (b) 2×10^7 m/s (c) 2×10^6 m/s (d) 2×10^5 m/s
Sol: (b)
Since, the wave length (λ) is increasing, we can say that the galaxy is receding. Doppler effect can be given by –
$\lambda' = \lambda \sqrt{\frac{c+v}{c-v}}$ . . . .(1)
or $706 = 656 \sqrt{\frac{c+v}{c-v}}$
or $\frac{c+v}{c-v} = \left(\frac{706}{656}\right)^2 = 1.16$
∴ $c + v = 1.16\, c – 1.16\, v$
∴ $v = \frac{0.16\, c}{2.16}$
$= \frac{0.16 \times 3.0 \times 10^8}{2.16}$ m/s
$= 0.22 \times 10^8$ m/s
$v \approx 2.2 \times 10^7$ m/s
If we take the approximation then Eq. (1) can be written as
$\Delta\lambda = \lambda \left(\frac{v}{c}\right)$ . . . . (2)
From here $v = \left(\frac{706-656}{656}\right)(3 \times 10^8)$m/s
$v = 0.23 \times 10^8$ m/s
which is almost equal to the previous answer. So, we may use Eq. (2) also.

5. Electrons with energy 80 keV are incident on the tungsten target of an X-ray tube. K-shell electrons of tungsten have 72.5 keV energy. X-rays emitted by the tube contain only :
(a) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of ≈ 0.155 Å
(b) a continuous X-ray spectrum (Bremsstrahlung) with all wavelengths
(c) the characteristic X-ray spectrum of tungsten
(d) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of ≈ 0.155 Å and the characteristic X-ray spectrum of tungsten.
Sol: (c)
Minimum wavelength of continuous X-ray spectrum is given by
λ_{min} (in Å) = $\frac{12375}{E(in\ eV)}$
Here, E = energy of incident electrons (in eV) = energy corresponding to minimum wavelength
λ_{min} = of X-rays
E = 80 eV
$= 80 \times 10^3$ eV
∴ λ_{min} (in Å) = $\frac{12375}{80 \times 10^3}$
≈ 0.155
Also the energy of the incident electrons (80 keV) is more than the ionization energy of the K-shell electrons (i.e., 72.5 keV). Therefore, characteristic X-ray spectrum will also be obtained because energy of incident electron is high enough to knock out the electron from K of L-shells.

6. The intensity of X-rays from a Coolidge tube is plotted against wavelength λ as shown in the figure. The minimum wavelength found is λ_e and the wavelength of the K_α line is λ_k. As the accelerating voltage is increased:



(a) $\lambda_k - \lambda_c$ increases (b) $\lambda_k - \lambda_c$ decreases (c) λ_k increases (d) λ_k decreases

Sol: (b)

One question on the same topic was asked in screening 2000 also. Keep in mind that characteristic wavelengths depend on the energy level diagrams of the target. For K-series, use the following formual:

$\frac{1}{\lambda}$ = $R(z-1)^2 \left(1 - \frac{1}{n^2}\right)$

n = 2 for K_α line, n = 3 for K_β line etc.

or $\frac{1}{\lambda} \propto \left(1 - \frac{1}{n^2}\right)$

Minimum wavelength in continuous spectrum depends on the accelerating voltage as

λ_{min} (in ú) = $\frac{12375}{V(in\ volts)}$

7. A hydrogen atom and a Li^{2+} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then:

(a) $1_H > 1_{Li}$ and $|E_H| > |E_{Li}|$ (b) $1_H > 1_{Li}$ and $|E_H| > |E_{Li}|$

(c) $1_H > 1_{Li}$ and $|E_H| > |E_{Li}|$ (d) $1_H > 1_{Li}$ and $|E_H| > |E_{Li}|$

Sol: (a)

In second excited state n = 2,

So, $l_H = l_{Li} = 3\left(\frac{h}{2\pi}\right)$

while $E \propto Z^2$ and $Z_H = 1$, $Z_{Li} = 3$

So, $|E_{Li}| = 9|E_H|$ or $|E_H| < |E_{Li}|$

8. The electric potential between a proton and an electron is given by V = $V_0 \ln \frac{r}{r_0}$, where r0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principlal quantum number?

(a) $r_n \propto n$ (b) $r_n \propto \frac{1}{n}$ (c) $r_n \propto n^2$ (d) $r_n \propto \frac{1}{n^2}$

Sol: (a)

$U = eV = eV_0 \text{ lh} \left(\frac{r}{r_0}\right)$

$|F| = \left|-\frac{dU}{dr}\right| = \frac{eV_0}{r}$

This force will provide the necessary centripetal force. Hence,

$\frac{mv^2}{r} = \frac{eV_0}{r}$

or $mvr = \sqrt{\frac{eV_0}{r}}$ . . . (1)

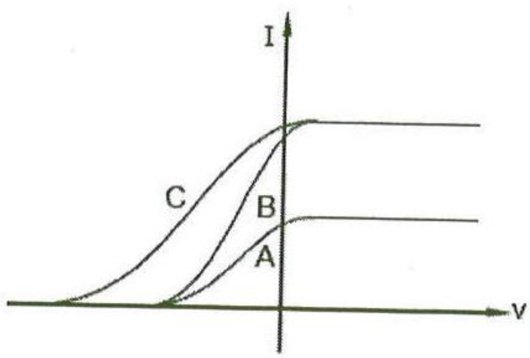
Moreover, $mvr = \frac{nh}{2\pi}$ . . . .(2)

Dividing Eq. (2) by (1), we have

$mr = \left(\frac{nh}{2\pi}\right)\sqrt{\frac{m}{eV_0}}$

or $r_n \propto n$

9. The figure shows the variation of photocurrent with anode potential for a photosensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively.



(a) $f_a = f_b$ and $I_a \neq I_b$ (b) $f_a = f_c$ and $I_a = I_c$ (c) $f_a = f_b$ and $I_a = I_b$ (d) $f_b = f_c$ and $I_b = I_c$

Saturation current is proportional to intensity while stopping potential increases with increase in frequency. Hence,

$f_a = f_b$ while $I_a < I_b$

Therefore, the correct option is (a)

10. A photon collides with a stationary hydrogen atom in ground state in elastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of macro second another photon collides with same hydrogen atom inelastically with an energy of 15 eV. What will be observed by the detector?
(a) 2 photon of energy 10.2 eV
(b) 2 photon of energy of 1.4 eV
(c) One photon of energy 10.2 eV and an electron of energy 1.4 eV
(d) One photon of energy 10.2 eV and another photon of energy 1.4 eV
Sol: (c)
This first photon will excite the hydrogen atom (in ground state) in first excited state (as $E_2 - E_1 = 10.2$ eV). Hence, during de-excitation a photon of 10.2 eV will be released. The second photon of energy 15 eV can ionize the atom. Hence the balance energy i.e.,
(15 – 13.6) eV = 1.4 eV is retained by the electron. Therefore, by the second photon an electron of energy 1.4 eV will be released.

Answer Keys

1	2	3	4	5	6	7	8	9	10	11
c	d		b	c	c	b	a	a	a	c

Atoms_Nuclei

PHYSICS

1. There are two radioactive substance A&B, Decay constant of B is two times that of A. Initially, both have equal number of nuclei. After n half lives of A, rate of distintegration of both are equal. The value of 'h' is
(a) 4 (b) 2 (c) 1 (d) 5
Let $\lambda_A = \lambda \therefore \lambda_B = 2\lambda$
If N_0 is total number of nuclei in A & B at t=0, times initial rate of distntegration of A = λN_0, and initial rate of disintegration of B = $2\lambda N_0$.
As $\lambda_B = 2\lambda_A \Rightarrow T_B = \frac{T_A}{2}$
After one half life of A
$\left(-\frac{dN}{dt}\right)_A = \frac{\lambda N_0}{2}$
Equivalently, after two half lives of B
$$\left(-\frac{dN}{dt}\right)_B = \frac{2\lambda N_0}{4} = \frac{\lambda N_0}{2}$$
$\therefore \left(-\frac{dN}{dt}\right)_A = \left(-\frac{dN}{dt}\right)_B$
After n = 1, i.e. one half life of A.

2. An unstable element is produced in neuclear reaction at a constant lkrate R. Its disintegration constant is λ. Find number of neuclei after time 't' if initially it was Zero
(a) $\frac{R}{\lambda}e^{-\lambda t}$ (b) $\frac{R}{\lambda}(1-e^{-\lambda t})$ (c) $\frac{R}{\lambda}(1+e^{\lambda t})$ (d) None of these
$$\frac{dN}{dt} = R - \lambda n \Rightarrow \int_0^N \frac{dN}{R-\lambda N} = \int_0^t dt$$
$\Rightarrow$ In $\left[\frac{R-\lambda N}{R}\right] = -\lambda t$
$\Rightarrow$ N = $\frac{R}{\lambda}\left[1-e^{-\lambda t}\right]$

3. In deuterium tritium fusion reaction find rate at which deuterium are consumed to produce 1 MW. The Q-value of deuterium-tritium reaction is 17.6 MeV. Assume 100% efficiency.
(a) 1.179×10^{-9}kg/sec (b) 1.179×10^{-10}kg/sec
(c) 1.179×10^{-11}kg/sec (d) 1.179×10^{-11}kg/sec.
Enegy released per fusion = 17.6 MeV number of fusion reaction to produce 1MW
$= \frac{10^6}{17.6\times.6\times10^{-19}\times10^6} = 3.35\times10^{17}$
In each reaction one atom of deuterium and one atom of tritium are consumed. Mass of deuterium consumed per second
$= \frac{2kg}{1K\ mol}\times\frac{1\ kmol}{6.023\times10^{26}}\times3.55\times10^{17}$ atom / sec
$= 1.179\times10^{-9} kg/sec.$

4. A radionuclide is produced at constant rate 'q' & halving half life T. Find time after which activity of neuclei will be A, if initially number of neuclei were zero.

(a) $\frac{TA}{q ln(2)}$ (b) $\frac{T}{In(2)} In\frac{A}{q}$ (c) $\frac{T}{In(2)} In\left(1-\frac{A}{q}\right)$ (d) None of these

$\frac{dN}{dt} = q - \lambda N$

$\Rightarrow \int_0^N \frac{dN}{q-\lambda N} = \int_0^t dt$

$\Rightarrow N = \frac{q}{\lambda}[1 - e^{-\lambda t}]$

$\Rightarrow N\lambda = q\left(1 - e^{-\lambda t}\right) \Rightarrow \frac{A}{q} = \left(1 - e^{-\lambda t}\right)$

$\Rightarrow t = \frac{1}{\lambda} In\left[1 - \frac{A}{q}\right] \Rightarrow t = \frac{T}{in(2)} In\left[1 - \frac{A}{q}\right]$

5. Find decay constant of radio nuclide if its activity decreases n(<1) fraction per time 't'. Final product is stable.

(a) $\frac{1}{t} In\left[\frac{1}{n}\right]$ (b) $\frac{1}{t} In\left[\frac{1+n}{1-n}\right]$ (c) $\frac{1}{t} In\left[\frac{1}{1-n}\right]$ (d) None of these

$A = \lambda N_0 e^{-\lambda t} = A_0 e^{-\lambda t} \Rightarrow log_e \frac{A}{A_0} = -\lambda t$ .... (1)

$A = A_0 - nA_0$ - - - - -(2) after time 't'

From (1) and (2)

$\ln \frac{A_0(1-n)}{A_0} = -\lambda t$

6. For a radioactive disintegration of half life T, with no. Of neuclei N. Find no. Of nuclei decayed in time Δt(<<T).

(a) $\frac{n\Delta t}{T}$ (b) $\frac{In2}{T} N\Delta t$ (c) $\frac{NT}{\Delta t}$ (d) None of these

$N\Delta = N\left(1 - e^{-\lambda t}\right)$

$\approx \lambda N\Delta t = \frac{In2}{T} N\Delta t$

7. A radioactive neucleus can decay in two different processes, the half life for the first process is t1 & that for thesecond process is t2 . Find effective half life.

(a) $\sqrt{t_1^2 + t_2^2}$ (b) $\frac{t_1 t_2}{t_1 - t_2}$ (c) $\frac{t_1 t_2}{\sqrt{t_1^2 + t_2^2}}$ (d) $\left[\frac{t_1 t_2}{t_1 + t_2}\right]$

$\frac{dN}{dt} = \left[\frac{dN}{dt}\right]_1 + \left[\frac{dn}{dt}\right]_2$

$\Rightarrow \lambda N = \lambda_1 N + \lambda_2 N$

$\Rightarrow \frac{In2}{T} = \frac{In(2)}{t_1} + \frac{In(2)}{t_2}$

8. A radioactive isotope is produced at constant rate 'R'. The isotope half life is $T_{t/2}$. For time t$\left(\gg T_{t/2}\right)$, number of neuclei

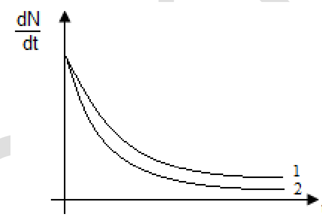
(a) R$T_{t/2}$ (b) $\frac{Rt}{In(2)}$ (c) $\frac{RT_{t/2}b}{In(2)}$ (d) Rt

$\frac{dN}{dt} = R - \lambda N$

$\Rightarrow \int_0^N \frac{dN}{R-\lambda N} = \int_0^t dt \Rightarrow In\left[\frac{R-\lambda N}{R}\right] = -\lambda t$

$\Rightarrow N \frac{R}{\lambda}\left(1 - e^{-\lambda t}\right)$for t $\rightarrow \infty$ N $\cong \frac{R}{\lambda} = \frac{Rt_{\frac{1}{2}}}{In(2)}$

9. For two different radioactive sample activity verses time curve is



(a)$\lambda_1 > \lambda_2$ (b) $\lambda_1 < \lambda_2$
(c) $\lambda_1 = \lambda_2$ (d) data insufficient

Area under curve is total no. Of nuclei

$\therefore A_{r1} > A_{r2}$

$\Rightarrow N_1 > N_2$

But initially both has same activity i.e.

$A_1 = A_2 \Rightarrow \lambda_1 N_1 = \lambda_2 N_2$ --- - -- - (2)

From (1) & (2)

$\lambda_1 < \lambda_2$

10. The minimum orbit angular momentum of the electron in a hydrogen atom is

(a) h (b) h/2 (c) h/2π (d) h/λ

Orbit angular momentum = $\frac{n.h}{2\pi} n = 1$

For H – atom

L = $\frac{h}{2\pi}(for\ n = 1)$

ANSWER KEY

1.c	2.b	3.a	4.c	5.	6.b	7.	8.c	9.b	10.c

1. Light of frequency 8×10^{15} Hz is incident on a substance of photoelectric work function 6.125 eV. Calculate the maximum kinetic energy of the emitted photoelectrons:
(a) 37 eV (b) 27.0 eV (c) 22.7 eV (d) 17 eV
K.E= h v-ω = $\frac{6.625\times10^{-34}\times8\times10^{15}}{1.6\times10^{-19}} - 6.125$
= 33.125 – 6.125 = 27.0 eV
Key: (b)

2. The stopping potential of a photoelectron emitter is determined to be 4 volts. The maximum velocity of an electron ejected by radiation is found to be (in m/sec)
(Assume charge to mass ratio of electron $\frac{e}{m} = 1.8 \times 10^{11}$ coulomb/kg)
(a) 8×10^5 (b) 6×10^5 (c) 2.1×10^6 (d) 1.2×10^6
$\frac{1}{2}mv^2 = eV$
$\Rightarrow v^2 = \frac{2eV}{m}$
$v = \sqrt{\frac{2eV}{m}} = \sqrt{2 \times 1.8 \times 10^{11} \times 4} = \sqrt{144 \times 10^{10}}$
= $12\times 10^5 = 1.2 \times 10^6$ m/s
Key: (d)

3. Photoelectrons are being emitted under the action of light. Suppose the frequency of the light is halved and its intensity is doubled. Then the speed of the electrons will
(a) decrease (b) increase
(c) stay unaltered (d) depends on the ratio of frequency to intensity
Speed of the electron depends on frequency and not on intensity. Hence when frequency is decreased the velocity is also decreased.
Key: (a)

4. The maximum velocity of an electron ejected from a photoelectric emitter when radiation falls on the latter is found to be 2×10^6 m/sec. Assuming the charge to mass ratio of electron $\frac{e}{m}$ to be 1.8×10^{11} coulomb/kg., the stopping potential is (in volts)
(a) 1.2 (b) 2.1 (c) 11.1 (d) 16.3
$\frac{1}{2}mv^2 = eV$ where V is stopping potential
V = $\frac{1}{2}\frac{mv^2}{e} = \frac{1}{2}\ \frac{v^2}{(e/m)}$
$= \frac{1}{2} \times \frac{(2\times10^6)^2}{1.8\times10^{11}} = 11.1\ V$
Ans: (c)

5. The minimum light intensity that can be perceived by the eye is about 10^{-12} Wm^{-2}. The number of photons of wavelength 6×10^{-7}m that must enter the pupil of area $10^{-4}m^2$ per second for vision is approximately equal to (h = $6.6\times10^{-34}$$J^{-s}$)
   (a) 3×10^2 photons (b) 3×10^3 photons (c) 3×10^4 photons (d) 3×10 photons
   Let n be the photons necessary for clear vision amount of energy falling on the pupil
   = nhv = $\frac{nhc}{\lambda}$
   ∴ Intensity = $\frac{Energy}{Unit\ area}$
   ⇒ $\frac{nhc}{\lambda \times area\ of\ the\ pupil}$
   By question $\frac{nhc}{\lambda \times area\ of\ the\ pupil} = 10^{-12}$

   ⇒ $\frac{n\times6.6\times10^{-34}\times3\times10^8}{6\times10^{-7}\times10^{-4}} = 10^{-12}$
   $n \times \frac{6.6}{2} \times 10^{-15} = 10^{-12}$

6. When a point source of light is 1 m away from a photoelectric cell, the photoelectric current is found to be 1 mA. If the same source be placed at 3 m from the same photoelectric cell, the photoelectric current will be:
   (a) $\frac{1}{3}$ (b) 3 I mA (c) 9 I mA (d) $\frac{I}{9}$
   Photoelectric current ∝ Intensity
   C ∝ I
   But I ∝ $\frac{1}{d^2}$
   ∴ C ∝ $\frac{1}{d^2}$
   $\frac{C_1}{C_2} = \frac{d_2^2}{d_1^2}; \frac{1}{C_2} = \frac{1^2}{3^2}$
   ∴ C_2 = 9 mA
   Key: (d)

7. Number of photons of wavelength 600nm emitted per second by an electric bulb of power 60 W is (take h=6×10^{-34} Js)
   (a) 10^{20} (b) 2×10^{20} (c) 600 (d) 60
   Let ‘ n’ be the no of photons emitted/s
   ⇒ Energy emitted/second = nhv = power
   nhv = 60, nh $\frac{c}{\lambda} = 60$
   ⇒ n = $\frac{60\times600\times10^{-9}}{6\times10^{-34}\times3\times10^8}$
   = $2\times 10^3 \times 10^{-9} \times 10^{26} = 2 \times 10^{20}$
   Key: (b)

8. Two radiations containing photons of energy twice and five times the work function of a metal are incident successively on the metal surface. The ratio of the maximum velocities of the emitted electrons in the two cases will be

(a) 1:3 (b) 1:4 (c) 1:2 (d) 1:1

$\frac{1}{2}mv^2 = hv - W$

I case: $\frac{1}{2}mv_1^2 = 2\omega - W$

$\Rightarrow \frac{1}{2}mv_1^2 = W$

II case: $\frac{1}{2}mv_1^2 = 5\omega - W \quad \Rightarrow \frac{1}{2}mv_2^2 = 4W$

$\frac{v_1^2}{v_2^2} = \frac{W}{4W} = \frac{1}{4}$

$\Rightarrow \frac{v_1}{v_2} = \frac{1}{2} = 1:2$

Key: (c)

9. A and B are two metals with threshold frequencies 1.8×10^{14} Hz and 2.2×10^{14} Hz. Two identical photons of energy 0.825eV each are incident on them. Then photoelectrons are emitted in (Take h = 6.6×10^{-34}Js)

(a) in both A and B (b) in neither A and B (c) A alone (d) B alone

v_A=1.8×10^{14} Hz v_B=2.2×10^{14} Hz

Frequency of the incident light = $\frac{eV}{h}, v = \frac{0.825\times(1.6\times10^{-19})}{6.6\times10^{-34}} = 0.20 \times 10^{15} Hz$

∴ v > v_A. Hence photoelectrons are not emitted in A.

Key: (d)

10. The Kinetic energy of the photoelectrons increases by 0.52 eV when the wavelength of incident light is changed from 500 nm to another wavelength which is approximately

(a) 700 nm (b) 400 nm (c) 1250 nm (d) 1000 nm

$\frac{hc}{\lambda_1} = x$

$\frac{hc}{\lambda_2} = x + 0.52$

$\Rightarrow \frac{hc}{\lambda_2} = \frac{hc}{\lambda_1} + 0.52$

$\Rightarrow \lambda_2 = \lambda_1 + \frac{hc}{0.52}$

$\Rightarrow \lambda_2 = 500 \times 10^{-9} + \frac{6.625\times10^{-34}\times3\times10^{8}}{0.52\times1.6\times10^{-19}}$

$\Rightarrow \lambda_2 = 414.9mm$

$\Rightarrow \lambda_2 \approx 400nm$

Key: (b)

11. When radiation of wave length λ is incident on a metal, stopping potential is 10 V. When the wavelength is 2λ the stopping potential becomes 4 V. Threshold wavelength of metal is

(a) 4λ (b) 3λ (c) 2λ (d) 6λ

K.E = hc $\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$

10 = hc $\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$ -------- (1)

4 = hc $\left[\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right]$ ------- (2)

$\frac{(1)}{(2)} \Rightarrow \left[\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right] = 4\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$

$\frac{5}{\lambda} - \frac{4}{\lambda} = \frac{10}{\lambda} - \frac{4}{\lambda_0}$

$\lambda_0 = 6\lambda$

Key: (d)

ANSWER KEY

1. B	2. D	3. A	4. C	5.	6. D	7. B	8. C	9. D	10. B

11. D

1. The deBroglie wavelength of a proton (charge=1.6×10^{-19}C, mass =n1.6×10^{-27}kg) accelerated through a p.d.of 1 kV is
   (a) 0.9×10^{-12}m (b) 600Å (c) 0.9 nm (d) 7Å
   $\lambda = \frac{h}{\sqrt{2mqV}} = \frac{6.625\times10^{-34}}{\sqrt{2\times1.6\times10^{-27}\times1.6\times10^{-19}\times1\times10^{3}}}$
   $= \frac{6.625\times10^{-34}}{1.6\times10^{-22}\sqrt{20}} = 0.9\times10^{-12}\mathrm{m}$
   Key: (a)

2. A proton and α particle have the same K.E. Their de Broglie wave lengths are in the ratio.
   (a) 1:1 (b) 1:2 (c) 2:1 (d) $\sqrt{2}:1$
   De Broglie wavelength λ = $\frac{h}{\sqrt{2mE}}$
   Since energy is same $\frac{\lambda_p}{\lambda_a} = \sqrt{\frac{m_a}{m_p}} = \sqrt{\frac{4}{1}} = 2$
   $\therefore \lambda_p:\lambda_a = 2:1$
   Key: (c)

3. If an electron and a proton have the same de Broglie wavelength, then the kinetic energy of the electron is
   (a) equal to that a proton (b) more than that of a proton
   (c) less than of proton (d) Zero
   $\lambda_c = \frac{\sqrt{2m_eE_e}}{h}$ $\lambda_p = \frac{\sqrt{2m_eE_e}}{h}$
   $\therefore \lambda_c = \lambda_p$
   $\Rightarrow m_eE_e = m_pE_p$
   $\because \lambda_c = \lambda_p$
   $\Rightarrow m_eE_e = m_pE_p$
   $\because m_e < m_p,\ E_e > E_p$
   Key: (b)

4. The kinetic energy of an electron gets tripled, then the de Broglie wavelength associated with it changes by a factor
   (a) 3 (b) 1/3 (c) $\sqrt{3}$ (d) $1/\sqrt{3}$
   $\lambda = \frac{h}{\sqrt{2mE}};\lambda' = \frac{h}{\sqrt{2m(3E)}}$
   $\lambda' = \frac{1}{\sqrt{3}}\lambda$
   Key: (d)

5. A proton and an alpha particle are subjected to same potential diffence V. Their de Broglie wavelengths λ_p and λ_a will be in the ratio

(a) 2:1 (b) $2\sqrt{2}:1$ (c) 4:1 (d) 1:1

$\lambda = \frac{1}{\sqrt{2mqV}}$

i.e. $\lambda\ \alpha = \frac{1}{\sqrt{mq}}$

$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{4m.2e}{m.e}}$

$= \sqrt{8} = \frac{2\sqrt{2}}{1} = 2\sqrt{2}:1$

Key: (b)

6. Photons of energy 5 eV and 10 eV are made to incident one after the other on a photosensitive material of work function 1 eV. Ratio of respective de Broglie wavelength of emitted otoelectrons in the two cases is

(a) $1:\sqrt{2}$ (b) 2:3 (c) $\sqrt{2}:1$ (d) 3:2

$\lambda = \frac{h}{\sqrt{2mE}}$

$\Rightarrow \lambda \propto \frac{1}{\sqrt{E}}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{9}{4}} = \frac{3}{2}$

Key: (d)

7. The de-Broglie wavelength associated with proton changes by 0.25% if its momentum is changed by P_0. The initial momentum was

(a) $100P_0$ (b) $P_0/400$ (c) 401 P_0 (D) P_0 /100

We know $\lambda = \frac{n}{p}$ ------- (1)

$\left[\lambda + \frac{0.25\lambda}{100}\right] = \frac{h}{(p-p_0)}$

$\Rightarrow \frac{100-25\lambda}{100} = \frac{h}{p-p_0}$ ------- (2)

From equation (1) and (2)

We get $\frac{100.25}{100} = \frac{p}{p-p_0}$

Solving we get p = 401 p_0

Key: (c)

8. A proton and an electron are accelerated by the same potential difference V. If λ_p and λ_a denote the wavelength associated with the proton and the electron respectively, then
(a) $\lambda_p > \lambda_e$ (b) $\lambda_e > \lambda_p$
(c) $\lambda_e = \lambda_p$ (d) $\lambda_e > \lambda_p$ for V > 1000 volt
For both proton and electron, kinetic energies are equal = eV
$\lambda_p = \frac{h}{\sqrt{2m_pK}}, \quad \lambda_e = \frac{h}{\sqrt{2m_pK}}$
$\therefore \frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}} > 1$ or $\lambda_e > \lambda_p$ for any arbitrary p.d.
Key: (b)

9. If the kinetic energy of a free electron is doubled, then the de Broglie wavelength is reduced by
(a) ½ (b) 2 (c) $1/\sqrt{2}$ (d) $\sqrt{2}$
$\lambda_1 = \frac{h}{\sqrt{2mK}}, \lambda_2 = \frac{h}{\sqrt{2m(2K)}} = \frac{\lambda_1}{\sqrt{2}}$
Key: (c)

10. If a strong diffraction peak is observed when electrons are incident at an angle i from the normal to the crystal planes with distance d between them, de Broglie wavelength λ of electrons can be calculated by the relationship (n is an integer).
(a) d sin i= 1λ (b) 2d cos i = n λ (c) 2d sin i = n λ (d) d cos i= n λ
If i is the angle of incident, glancing angle is θ = 90 – i.
According to Bragg's law,
2d sin θ = n λ i.e., 2d sin (90 - i) = n λ
or 2d cos i = n λ
Key: (b)

ANSWER KEY

1. A	2. C	3. B	4. D	5. B	6. D	7. C	8. B	9. C	10. B

1. If an alpha particle is projected with a K.E = E_k towards an atom having atomic number and the angle of scattering θ, then the impact parameter is
   (a) $\frac{Ze^2 Cot\left(\frac{\theta}{2}\right)}{4\pi\epsilon_0(E_K)}$ (b) $\frac{ZeCot\left(\frac{\theta}{2}\right)}{4\pi\epsilon_0(E_K)}$
   (c) $\frac{Ze^2 Cot(\theta)}{4\pi\epsilon_0(E_K)}$ (d) $\frac{ZeCot(\theta)}{4\pi\epsilon_0(E_K)}$
   Ans: a

2. A 12.5 MeV α - particle approaching a gold nucleus is deflected by 180^0. How close does it approach the nucleus ?
   (a) $1.82 \times 10^{-14} m$ (b) $1.82 \times 10^{-16} m$
   (c) $1.82 \times 10^{-12} m$ (d) $1.82 \times 10^{-11} m$
   Hint: electric potential energy = kinetic energy
   Ans: a

3. The radius of the 1st Bohr's orbit is $0.53A^0$. Then the radius of 3rd Bohr orbit is
   (a) $2.12A^0$ (b) $4.77A^0$ (c) $0.75A^0$ (d) $1.75A^0$
   Hint: $r_n = n^2 r_1$
   Ans: (b)

4. The velocity of electron in the first orbit of the hydrogen atom is (c - speed of light)
   $(a)\ \frac{c}{157}$ $(b)\ \frac{c}{147}$ $(c)\ \frac{c}{137}$ $(d)\ \frac{c}{127}$
   Ans: (c)

5. It is found experimentally that 13.6 eV energy is required to separate a Hydrogen atom into a proton and an electron. The radius of the electron in a Hydrogen atom
   (a) $5.3 \times 10^{-11} m$ (b) $5.3 \times 10^{-10} m$
   (c) $5.3 \times 10^{-9} m$ (d) $5.3 \times 10^{-8} m$
   Hint: $\frac{Ze^2}{4\pi\epsilon_0 r_1} = 13.6 \times 10^6 \times e \ \ (joules)$:
   Ans: (a)

6. Using the Rydberg's formula, Calculate the wavelength of first spectral line in the Lyman series of Hydrogen spectrum ($R = 1.097 \times 10^7 m^{-1}$)
   (a) $1215A^0$ (b) $1128A^0$
   (c) $1318A^0$ (d) $1283A^0$
   Hint: $\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$
   Ans: (a)

7. The ground state energy of Hydrogen atom is $-13.6\, eV$. If an electron makes a transition from an energy level $-0.85\, eV$ to $-3.4\, eV$, calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong?

(a) $4852A^0$ Balmer series (b) $4852A^0$Lyman series

(c) $5842\, A^0$ Balmer series (d) $5842\, A^0$ Lyman series

Hint:

$$E_2 = \frac{13.6}{n_2^2} = -0.85\, eV \quad , \quad E_1 = \frac{13.6}{n_1^2} = -3.4\, eV$$

$$E_2 - E_1 = -3.4\, eV - (-0.85\, eV) = 1.55\, eV \rightarrow \text{Convert this into } J$$

$$\frac{hc}{\lambda} = (E_2 - E_1)\, in\, J$$

Ans: (a)

8. The ground state energy of electron in case of ${}_3Li^7$ is,,

(a) $-130.4\, eV$ (b) $-122.4\, eV$

(c) $-125.5\, eV$ (d) $-126.8\, eV$

Hint: $E_n\ \alpha\ \frac{z^2}{n^2}$

Ans: (b)

9. The wavelength of some of the spectral lines obtained in Hydrogen spectrum are $1216A^0, 6463A^0\ and\ 9546A^0$. Which one of these wavelengths belong to the Paschen series?

(a) $1216A^0$ (b) $6463A^0$ (c) $9546A^0$ (d) All of these

Hint: A belongs to Lyman series , b belongs to Balmer series

Ans: (c)

10. Hydrogen atom emits blue light when it changes from n=4 energy level to the n=2 level and which colour of light would the atom emit when it changes from the n=5 to n=2 level?

(a) Red (b) yellow (c) Green (d) Violet

Hint: (E_5 - E_2) > (E_4 - E_2) ,

Ans: Violet since it has a lower wavelength than blue

ANSWER KEY

1. A	2. A	3. B	4. C	5. A	6. A	7. A	8. B	9. C	10. D

1. The half-life of radioactive Radon is 3.8 days. The time, at the end of which $\left(\frac{1}{32}\right)^{th}$ of the radon sample will remain un-decayed is
   (a) 3.8 days (b) 19 days (c) 33 days (d) 76 days
   Hint: $N_t = \frac{N_0}{2^n}$
   Ans: (b)

2. At an instant there are 10^6 active nuclei of a radioactive element. If the half-life is 20 seconds then the number of nuclei left 10 seconds later is
   (a) 5×10^5 (b) 7.5×10^5
   (c) $\sqrt{2} \times 10^5$ (d) $\frac{10^6}{\sqrt{2}}$
   Hint: $N_t = \frac{N_0}{2^n}$ n = ½ ,
   Ans: (d)

3. An accident occurs in a laboratory in which a large amount of radio-active material having a half-life of 20 days becomes embedded in the floor and walls so that the level of radiation is 32 times the permissible level. The laboratory can be safely occupied after
   (a) 20 days (b) 32 days (c) 64 days (d) 100 days
   Hint: $N_t = \frac{N_0}{2^n}$
   Ans: (d)

4. After two hours $\left(\frac{1}{16}\right)^{th}$ of the initial amount of a certain radioactive isotope remains un-decayed. The half-life of the isotope is
   (a) 1 hour (b) 45 min (c) 30 min (d) 15 min
   Hint: $N_t = \frac{N_0}{2^n}$
   Ans: (d)

5. If 10% of a radioactive material decays in 5 days, then the amount of the original material left after 15 days is nearly equal to
   (a) 27.1 % (b) 30 % (c) 70% (d) 72.9 %
   Hint: $N = N_0 e^{-\lambda t}$
   Ans : (d)

6. The tissue of a living animal is estimated to contain 100 atoms of out of every atoms of C .A fossil of the animal is found to contain only 10 atoms of C . If half-life of is 6600 years then the age fossils is nearly
   (a)35,000 years (b) 20,000 years
   (c) 48,000 years (d) 64,000 years
   Hint : $N_t = \frac{N_0}{2^n}$
   Ans: (b)

7. A fraction of a radioactive sample decays in one mean life, and the other fraction decays in one half-life. Then
   (a) $f_1 > f_2$ (b) $f_1 < f_2$ (c) $f_1 = f_2$ (d) None of these
   Hint: $t_{1/2} < t$
   Ans : (a)

8. Two radioactive substances A and B have their half-lives 15 minutes and 30 minutes. Initially both have the same number of active atoms. After 1 hour the ratio of their activities is
   (a) 1 : 4 (b) 4 : 1 (c) 1 : 2 (d) 2 : 1
   Ans: (c)

9. Two radioactive substances of half-life 1hr and 2hr contain initially the same number of atoms. At the end of 2 hours their activities will be in the ratio of
   (a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) 1 : 4
   Ans : (c)

10. A radioactive nuclide can decay simultaneously by two different processes which have decay constants λ_1 and λ_2 . The effective decay constant of the nuclide is . Then
   (a) $\lambda = \lambda_1 + \lambda_2$ (b) $\lambda = \frac{\lambda_1+\lambda_2}{2}$
   (c) $\frac{1}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$ (d) $\lambda = \sqrt{\lambda_1\lambda_2}$
   Hint: Net activity = Activity 1 + Activity 2
   Ans: (a)

ANSWER KEY

1. B	2. D	3. D	4. D	5. D	6. B	7. A	8. C	9. C	10. A

Communication Systems

PHYSICS

1. Frequencies in the U.H.F range normally propagates by means of
(a) Ground Waves (b) Sky Waves (c) Surface Waves (d) Space Waves

2. Digital Signals
(i) do not provide a continuous set of values
(ii) represent values as discrete steps
(iii) can utilize binary system
(iv) can utilize decimal as well as binary system
Which of the above statements are true ?
(a) (i) and (iii) only (b) (ii) and (iii) only (c) (i), (ii) and (iii) (d) All the above

3. The maximum distance upto which the T.V transmission from a T.V tower of height 'h' can be received is proportional to
(a) $h^{1/2}$ (b) h (c) $h^{3/2}$ (d) h^2

4. A T.V tower has a height of 75m. The maximum distance upto which this T.V transmission can be received is
(a) 28Km (b) 31Km (c) 46Km (d) 51Km

5. A message signal of frequency 10KHz and peak voltage of 10volt is used to modulate a carrier of frequency 1MHz and peak voltage of 20volt. The side bands produced are
(a) 1000KHz, 900KHz (b) 1100KHz, 990KHz (c) 1010KHz, 990KHz (d) none of the above.

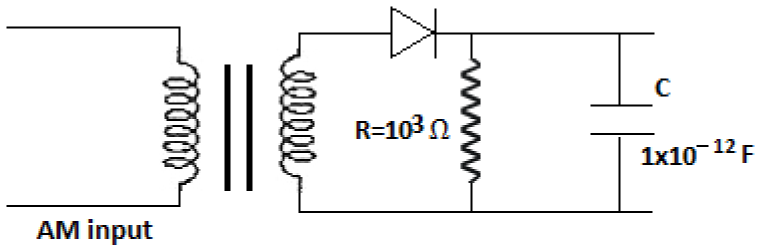
6. A wave is represented as e=10 sin ($10^8 t$+ 6 sin 1250 t)then the modulating index is
(a) 10 (b) 1250 (c) 10^8 (d) 6

7. A carrier wave of peak voltage 12V is used to transmit a message signal. In order to have a modulation index of 75%, the peak voltage of the modulating signal should be
(a) 3V (b) 6V (c) 9V (d) 12V

8. A ground receiver station is receiving a signal at 5MHz and transmitted from a ground transmitter at a height of 300m, located at a distance of 100km from the receiver station. The signal is coming via-
[R_{earth}= 6.4 X 10^6m ; N_{max} of the ionosphere = $10^{12} m^3$]
(a) space wave (b) sky wave propagation (c) satellite transponder (d) All of these.

9. An optical fibre communication system works on a wavelength of 1.3μm .The number of subscribes it can feed if a channel requires 20KHz are
(a) 2.3 X 10^{10} (b) 1.15 X 10^{10} (c) 1 X 10^5 (d) none of the these.

10. In the given detector circuit, the suitable value of carrier frequency is



(a) << 10^9Hz (b)<<10^5Hz (c) >>10^9Hz (d) none of the these.

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
d	d	a	b	c	d	c	b	b	a

Current Electricity

PHYSICS

1. Every atom makes one free electron in copper. If 1.1 ampere current is flowing in the wire of copper having 1mm diameter, then the drift velocity (approx.) will be (Density of copper $= 9 \times 10^3\ kg\ m^{-3}$ and atomic weight = 63)
   (a) $0.3\,mm/\sec$ (b) $0.1\,mm/\sec$ (c) $0.2\,mm/\sec$ (d) $0.2\,cm/\sec$

2. If a 0.1 % increase in length due to stretching, the percentage increase in its resistance will be
   (a) 0.2 % (b) 2 % (c) 1 % (d) 0.1 %

3. In hydrogen atom, the electron makes 6.6×10^{15} revolutions per second around the nucleus in an orbit of radius $0.5 \times 10^{-10}\,m$. It is equivalent to a current nearly
   (a) 1 A (b) 1 mA (c) $1\,\mu A$ (d) $1.6 \times 10^{-19}\,A$

4. A wire of length 5 m and radius 1 mm has a resistance of 1 ohm. What length of the wire of the same material at the same temperature and of radius 2 mm will also have a resistance of 1 ohm
   (a) 1.25 m (b) 2.5 m (c) 10 m (d) 20 m

5. The specific resistance of a wire is ρ, its volume is 3 m^3 and its resistance is 3 ohms, then its length will be
   (a) $\sqrt{\frac{1}{\rho}}$ (b) $\frac{3}{\sqrt{\rho}}$ (c) $\frac{1}{\rho}\sqrt{3}$ (d) $\rho\sqrt{\frac{1}{3}}$

6. 62.5$\times 10^{18}$electrons per second are flowing through a wire of area of cross-section 0.1 m^2, the value of current flowing will be
   (a) 1 A (b) 0.1 A (c) 10 A (d) 0.11 A

7. A piece of wire of resistance 4 ohms is bent through $180°$ at its mid point and the two halves are twisted together, then the resistance is
   (a) 8 ohms (b) 1 ohm (c) 2 ohms (d) 5 ohms

8. In an electrolyte 3.2×10^{18} bivalent positive ions drift to the right per second while 3.6×10^{18} monovalent negative ions drift to the left per second. Then the current is
   (a) 1.6 amp to the left (b) 1.6 amp to the right
   (c) 0.45 amp to the right (d) 0.45 amp to the left

9. In an electrical cable there is a single wire of radius 9 mm of copper. Its resistance is $5\,\Omega$. The cable is replaced by 6 different insulated copper wires, the radius of each wire is $3\,mm$. Now the total resistance of the cable will be
   (a) $7.5\,\Omega$ (b) $45\,\Omega$ (c) $90\,\Omega$ (d) $270\,\Omega$

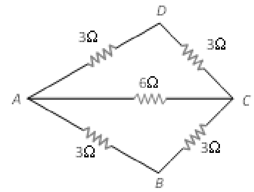
10. Two wires of resistance R_1 and R_2 have temperature coefficient of resistance α_1 and α_2, respectively. These are joined in series. The effective temperature coefficient of resistance is

(a) $\frac{\alpha_1 + \alpha_2}{2}$ (b) $\sqrt{\alpha_1 \alpha_2}$ (c) $\frac{\alpha_1 R_1 + \alpha_2 R_2}{R_1 + R_2}$ (d) $\frac{\sqrt{R_1 R_2 \alpha_1 \alpha_2}}{\sqrt{R_1^2 + R_2^2}}$

ANSWER KEYS

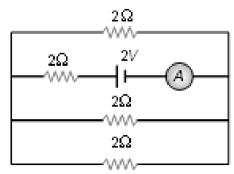
1. b	2. a	3. b	4. d	5. b	6. c	7. b	8. b	9. a	10. c

1. The effective resistance between the points A and B in the figure is



(a) $5\,\Omega$
(b) $2\,\Omega$
(c) $3\,\Omega$
(d) $4\,\Omega$

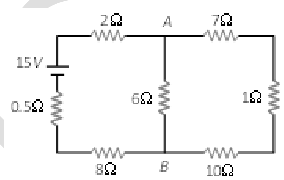
2. The reading of the ammeter as per figure shown is



(a) $\frac{1}{8}A$
(b) $\frac{3}{4}A$
(c) $\frac{1}{2}A$
(d) 2 A

3. Resistors of 1, 2, 3 ohm are connected in the form of a triangle. If a 1.5 volt cell of negligible internal resistance is connected across 3 ohm resistor, the current flowing through this resistance will be
(a) 0.25 amp (b) 0.5 amp (c) 1.0 amp (d) 1.5 amp

4. The current from the battery in circuit diagram shown is



(a) 1 A
(b) 2 A
(c) 1.5 A
(d) 3 A

5. Two wires of equal diameters, of resistivities ρ_1 and ρ_2 and lengths l_1 and l_2, respectively, are joined in series. The equivalent resistivity of the combination is
(a) $\frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$ (b) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 - l_2}$
(c) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 + l_2}$ (d) $\frac{\rho_1 l_1 - \rho_2 l_2}{l_1 - l_2}$

6. Two wires of the same material and equal length are joined in parallel combination. If one of them has half the thickness of the other and the thinner wire has a resistance of 8 ohms, the resistance of the combination is equal to
(a) $\frac{5}{8}\,ohms$ (b) $\frac{8}{5}\,ohms$ (c) $\frac{3}{8}\,ohms$ (d) $\frac{8}{3}\,ohms$

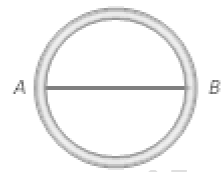
7. Two resistance wires on joining in parallel the resultant resistance is $\frac{6}{5}\ ohms$. One of the wire breaks, the effective resistance is 2 ohms. The resistance of the broken wire is

(a) $\frac{3}{5}\ ohm$ (b) 2 ohm (c) $\frac{6}{5}\ ohm$ (d) 3 ohm

8. The resistance of a wire is $10^{-6}\Omega$ per metre. It is bend in the form of a circle of diameter $2m$. A wire of the same material is connected across its diameter. The total resistance across its diameter AB will be

(a) $\frac{4}{3}\pi\times10^{-6}\Omega$ (b) $\frac{2}{3}\pi\times10^{-6}\Omega$

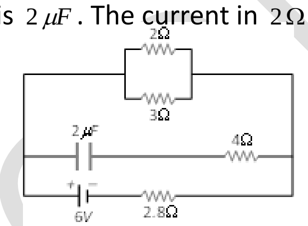
(c) $0.88\times10^{-6}\Omega$ (d) $14\pi\times10^{-6}\Omega$



9. In the figure shown, the capacity of the condenser C is $2\mu F$. The current in 2Ω resistor is

(a) 9 A (b) 0.9 A

(c) $\frac{1}{9}A$ (d) $\frac{1}{0.9}A$



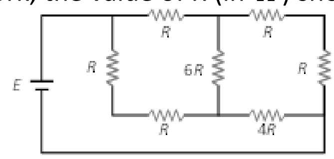
10. The current in a conductor varies with time t as $I = 2t + 3t^2$ where I is in ampere and t in seconds. Electric charge flowing through a section of the conductor during t = 2 sec to t = 3 sec is

(a) 10 C (b) 24 C (c) 33 C (d) 44 C

ANSWER KEYS

1. b	2. b	3. b	4. b	5. b	6. b	7. b	8. c	9. b	10. b

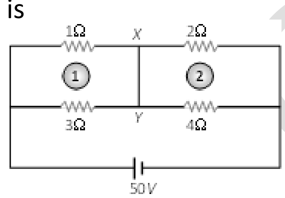
1. A battery of internal resistance 4Ω is connected to the network of resistances as shown. In order to give the maximum power to the network, the value of R (in Ω) should be



(a) 4/9
(b) 8/9
(c) 2
(d) 18

2. The resistance of a wire of iron is 10 ohms and temp. coefficient of resistivity is $5\times10^{-3}/°C$. At $20°C$ it carries 30 milliamperes of current. Keeping constant potential difference between its ends, the temperature of the wire is raised to $120°C$. The current in milliamperes that flows in the wire is
(a) 20 (b) 15 (c) 10 (d) 40

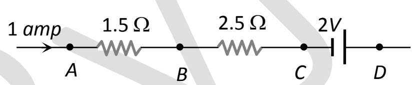
3. Current through wire XY of circuit shown is



(a) 1 A
(b) 4 A
(c) 2 A
(d) 3 A

4. 12 cells each having same emf are connected in series with some cells wrongly connected. The arrangement is connected in series with an ammeter and two cells which are in series. Current is 3 A when cells and battery aid each other and is 2 A when cells and battery oppose each other. The number of cells wrongly connected is
(a) 4 (b) 1 (c) 3 (d) 2

5. In the circuit element given here, if the potential at point B, $V_B = 0$, then the potentials of A and D are given as



(a) $V_A = -1.5\,V, V_D = +2\,V$ (b) $V_A = +1.5\,V, V_D = +2\,V$
(c) $V_A = +1.5\,V, V_D = +0.5\,V$ (d) $V_A = +1.5\,V, V_D = -0.5\,V$

6. The n rows each containing m cells in series are joined in parallel. Maximum current is taken from this combination across an external resistance of 3Ω resistance. If the total number of cells used are 24 and internal resistance of each cell is 0.5 Ω then
(a) $m = 8, n = 3$ (b) $m = 6, n = 4$ (c) $m = 12, n = 2$ (d) $m = 2, n = 12$

7. A cell of constant e.m.f. first connected to a resistance R_1 and then connected to a resistance R_2. If power delivered in both cases is equal then the internal resistance of the cell is
(a) $\sqrt{R_1R_2}$ (b) $\sqrt{\frac{R_1}{R_2}}$ (c) $\frac{R_1 - R_2}{2}$ (d) $\frac{R_1 + R_2}{2}$

8. A battery is charged at a potential of 15 V for 8 hours when the current flowing is 10 A. The battery on discharge supplies a current of 5 A for 15 hours. The mean terminal voltage during discharge is 14 V. The "Watt-hour" efficiency of the battery is
(a) 82.5% (b) 80 % (c) 90% (d) 87.5%

9. When the resistance of 9 Ω is connected at the ends of a battery, its potential difference decreases from 40 volt to 30 volt. The internal resistance of the battery is
(a) 6 Ω (b) 3 Ω (c) 9 Ω (d) 15 Ω

10. The maximum power drawn out of the cell from a source is given by (where r is internal resistance)
(a) $E^2/2r$ (b) $E^2/4r$ (c) E^2/r (d) $E^2/3r$

ANSWER KEYS

1. c	2. a	3. c	4. b	5. d	6. c	7. a	8. d	9. b	10. b

1. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be
(a) 99995 (b) 9995 (c) 10^3 (d) 10^5

2. A galvanometer of $100\,\Omega$ resistance gives full scale deflection when 10 mA of current is passed. To convert it into 10 A range ammeter, the resistance of the shunt required will be
(a) $-10\,\Omega$ (b) $1\,\Omega$ (c) $0.1\,\Omega$ (d) $0.01\,\Omega$

3. 100 mA Current gives a full scale deflection in a galvanometer of $2\,\Omega$ resistance. The resistance connected with the galvanometer to convert it into a voltmeter to measure $5\,V$ is
(a) $98\,\Omega$ (b) $52\,\Omega$ (c) $50\,\Omega$ (d) $48\,\Omega$

4. When a $12\,\Omega$ resistor is connected with a moving coil galvanometer then its deflection reduces from 50 divisions to 10 divisions. The resistance of the galvanometer is
(a) $24\,\Omega$ (b) $36\,\Omega$ (c) $48\,\Omega$ (d) $60\,\Omega$

5. A potentiometer is used for the comparison of e.m.f. of two cells E_1 and E_2. For cell E_1 the no deflection point is obtained at 20 cm and for E_2 the no deflection point is obtained at 30 cm. The ratio of their e.m.f.'s will be
(a) 2/3 (b) 1/2 (c) 1 (d) 2

6. The current flowing through a coil of resistance 900 ohms is to be reduced by 90%. What value of shunt should be connected across the coil
(a) $90\,\Omega$ (b) $100\,\Omega$ (c) $9\,\Omega$ (d) $10\,\Omega$

7. For comparing the e.m.f.'s of two cells with a potentiometer, a standard cell is used to develop a potential gradient along the wires. Which of the following possibilities would make the experiment unsuccessful
(a) The e.m.f. of the standard cell is larger than the E e.m.f.'s of the two cells
(b) The diameter of the wires is the same and uniform throughout
(c) The number of wires is ten
(d) The e.m.f. of the standard cell is smaller than the e.m.f.'s of the two cells

8. In a meter bridge, the balancing length from the left end (standard resistance of one ohm is in the right gap) is found to be 20 cm. The value of the unknown resistance is
(a) $0.8\,\Omega$ (b) $0.5\,\Omega$ (c) $0.4\,\Omega$ (d) $0.25\,\Omega$

9. In a potentiometer experiment, the galvanometer shows no deflection when a cell is connected across 60 cm of the potentiometer wire. If the cell is shunted by a resistance of $6\,\Omega$, the balance is obtained across 50 cm of the wire. The internal resistance of the cell is
(a) $0.5\,\Omega$ (b) $0.6\,\Omega$ (c) $1.2\,\Omega$ (d) $1.5\,\Omega$

10. A galvanometer having a resistance of 8 ohm is shunted by a wire of resistance 2 ohm. If the total current is 1 amp, the part of it passing through the shunt will be
    (a) 0.25 amp (b) 0.8 amp (c) 0.2 amp (d) 0.5 am

ANSWER KEYS

1. a	2. c	3. d	4. c	5. a	6. b	7. d	8. d	9. c	10. b

1. Current of 4.8 amperes is flowing through a conductor. The number of electrons per second will be
   (a) 3×10^{19} (b) 7.68×10^{21} (c) 7.68×10^{20} (d) 3×10^{20}

2. When the current i is flowing through a conductor, the drift velocity is v. If $2i$ current is flowed through the same metal but having double the area of cross-section, then the drift velocity will be
   (a) $v/4$ (b) $v/2$ (c) v (d) $4v$

3. The temperature coefficient of resistance for a wire is $0.00125/°C$. At 300K its resistance is 1 ohm. The temperature at which the resistance becomes 2 ohm is
   (a) 1154 K (b) 1100 K (c) 1400 K (d) 1127 K

4. When the length and area of cross-section both are doubled, then its resistance
   (a)Will become half (b) Will be doubled
   (c) Will remain the same (d) Will become four times

5. The resistance of a wire is 20 ohms. It is so stretched that the length becomes three times, then the new resistance of the wire will be
   (a) 6.67 ohms (b) 60.0 ohms (c) 120 ohms (d) 180.0 ohms

6. Two wires of the same material are given. The first wire is twice as long as the second and has twice the diameter of the second. The resistance of the first will be
   (a) Twice of the second (b) Half of the second
   (c) Equal to the second (d) Four times of the second

7. There is a current of 20 amperes in a copper wire of 10^{-6} square metre area of cross-section. If the number of free electrons per cubic metre is 10^{29}, then the drift velocity is
   (a) $125\times10^{-3}\,m/sec$ (b) $12.5\times10^{-3}\,m/sec$
   (c) $1.25\times10^{-3}\,m/sec$ (d) $1.25\times10^{-4}\,m/sec$

8. The resistance of a wire is $10\,\Omega$. Its length is increased by 10% by stretching. The new resistance will now be
   (a) $12\,\Omega$ (b) $1.2\,\Omega$ (c) $13\,\Omega$ (d) $11\,\Omega$

9. Pick out the wrong statement
   (a) In a simple battery circuit, the point of lowest potential is the negative terminal of the battery
   (b) The resistance of an incandescent lamp is greater when the lamp is switched off
   (c) An ordinary 100 W lamp has less resistance than a 60 W lamp
   (d) At constant voltage, the heat developed in a uniform wire varies inversely as the length of the wire use

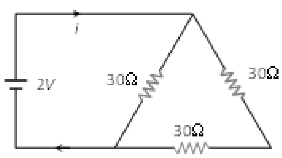
10. A heating coil is labelled 100 W, 220 V. The coil is cut in half and the two pieces are joined in parallel to the same source. The energy now liberated per second is
(a) 200 J (b) 400 J (c) 25 J (d) 50 J

ANSWER KEY

1. a	2. c	3. d	4. c	5. d	6. b	7. c	8. a	9. a	10. b

1. A wire of resistance R is divided in 10 equal parts. These parts are connected in parallel, the equivalent resistance of such connection will be
   (a) 0.01 R (b) 0.1 R (c) 10 R (d) 100 R

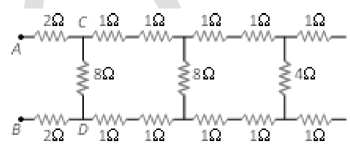
2. The current in the adjoining circuit will be



   (a) $\frac{1}{45}\,ampere$ (b) $\frac{1}{15}\,ampere$
   (c) $\frac{1}{10}\,ampere$ (d) $\frac{1}{5}\,ampere$

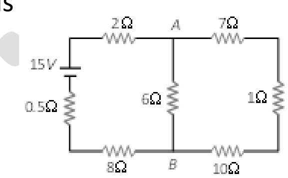
3. There are n similar conductors each of resistance R. The resultant resistance comes out to be x when connected in parallel. If they are connected in series, the resistance comes out to be
   (a) x/n^2 (b) n^2x (c) x/n (d) nx

4. In the figure shown, the total resistance between A and B



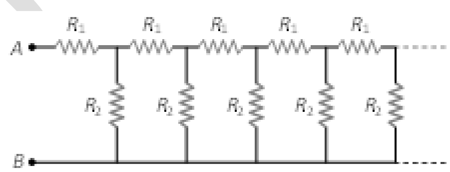
is
   (a) $12\,\Omega$ (b) $4\,\Omega$
   (c) $6\,\Omega$ (d) $8\,\Omega$

5. The current from the battery in circuit diagram shown is



   (a) 1 A
   (b) 2 A
   (c) 1.5 A
   (d) 3 A

6. An infinite sequence of resistance is shown in the figure. The resultant resistance between A and B will be, when $R_1 = 1\,ohm$ and $R_2 = 2\,ohm$



   (a) Infinity (b) 1 Ω (c) 2 Ω (d) 1.5 Ω

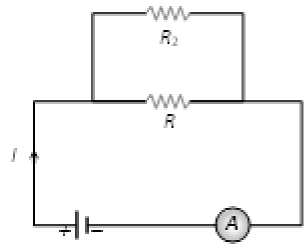
7. If a resistance R_2 is connected in parallel with the resistance R in the circuit shown, then possible value of current through R and the possible value of R_2 will be

(a) $\frac{I}{3}, R$

(b) $I, 2R$

(c) $\frac{I}{3}, 2R$

(d) $\frac{I}{2}, R$

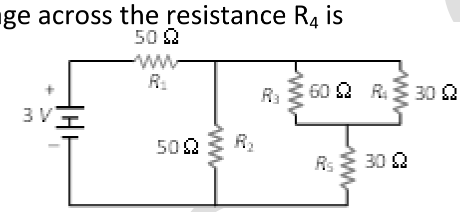


8. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be

(a) 3 (b) 1/3 (c) 8/9 (d) 2

9. In circuit shown below, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3 volt. The voltage across the resistance R_4 is

(a) 0.4 V
(b) 0.6 V
(c) 1.2 V
(d) 1.5 V



10. The current in a simple series circuit is 5.0 amp. When an additional resistance of 2.0 ohms is inserted, the current drops to 4.0 amp. The original resistance of the circuit in ohms was

(a)1.25 (b) 8 (c) 10 (d) 20

ANSWER KEY

1. a	2. c	3. b	4. a	5. a	6. c	7. d	8. b	9. a	10. b

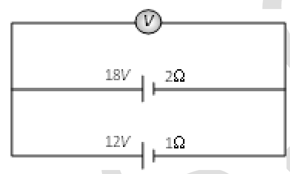
1. By a cell a current of 0.9 A flows through 2 ohm resistor and 0.3 A through 7 ohm resistor. The internal resistance of the cell is
(a) $0.5\,\Omega$ (b) $1.0\,\Omega$ (c) $1.2\,\Omega$ (d) $2.0\,\Omega$

2. A primary cell has an e.m.f. of 1.5 volts, when short-circuited it gives a current of 3 amperes. The internal resistance of the cell is
(a) 4.5 ohm (b) 2 ohm (c) 0.5 ohm (d) 1/4.5 ohm

3. The number of dry cells, each of e.m.f. 1.5 volt and internal resistance 0.5 ohm that must be joined in series with a resistance of 20 ohm so as to send a current of 0.6 ampere through the circuit is
(a) 2 (b) 8 (c) 10 (d) 12

4. A fuse wire with radius 1 mm blows at 1.5 amp. The radius of the fuse wire of the same material to blow at 3A will be
(a) $4^{1/3}\,mm$ (b) $3^{1/4}\,mm$ (c) $2^{1/2}\,mm$ (d) $3^{1/2}\,mm$

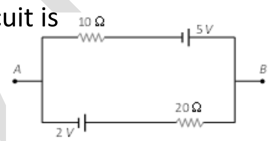
5. Two batteries, one of emf 18 volts and internal resistance 2Ω and the other of emf 12 volt and internal resistance 1Ω, are connected as shown. The voltmeter V will record a reading of



(a) 15 volt
(b) 30 volt
(c) 14 volt
(d) 18 volt

6. A battery is charged at a potential of 15 V for 8 hours when the current flowing is 10 A. The battery on discharge supplies a current of 5 A for 15 hours. The mean terminal voltage during discharge is 14 V. The "Watt- hour" efficiency of the battery is
(a) 82.5% (b) 80 % (c) 90% (d) 87.5%

7. The current in the given circuit is



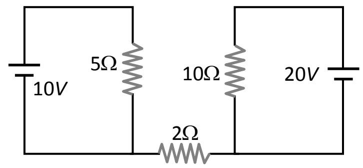
(a) 0.1 A
(b) 0.2 A
(c) 0.3 A
(d) 0.4 A

8. For driving a current of 2 A for 6 minutes in a circuit, 1000 J of work is to be done. The e.m.f. of the source in the circuit is
(a) 1.38 V (b) 1.68 V (c) 2.04 V (d) 3.10 V

9. A battery has e.m.f. 4 V and internal resistance r. When this battery is connected to an external resistance of 2 ohms, a current of 1 amp. flows in the circuit. How much current will flow if the terminals of the battery are connected directly
(a) 1 amp (b) 2 amp (c) 4 amp (d) Infinite

10. Find out the value of current through 2Ω resistance for the given circuit

(a) 5 A
(b) 2 A
(c) Zero
(d) 4 A



KEY

1. a	2. c	3. c	4. c	5. c	6. d	7. a	8. a	9. b	10. c

1. 50 Ω and 100Ω resistors are connected in series. This connection is connected with a battery of 2.4 volts. When a voltmeter of $100\,\Omega$ resistance is connected across $100\,\Omega$ resistor, then the reading of the voltmeter will be
   (a) 1.6 V (b) 1.0 V (c) 1.2 V (d) 2.0 V

2. A 2 volt battery, a $15\,\Omega$ resistor and a potentiometer of 100 cm length, all are connected in series. If the resistance of potentiometer wire is $5\,\Omega$, then the potential gradient of the potentiometer wire is
   (a) 0.005 V/cm (b) 0.05 V/cm (c) 0.02 V/cm (d) 0.2 V/cm

3. When a $12\,\Omega$ resistor is connected with a moving coil galvanometer then its deflection reduces from 50 divisions to 10 divisions. The resistance of the galvanometer is
   (a) $24\,\Omega$ (b) $36\,\Omega$ (c) $48\,\Omega$ (d) $60\,\Omega$

4. A galvanometer of 10 ohm resistance gives full scale deflection with 0.01 ampere of current. It is to be converted into an ammeter for measuring 10 ampere current. The value of shunt resistance required will be
   (a) $\frac{10}{999}$ ohm (b) 0.1 ohm (c) 0.5 ohm (d) 1.0 ohm

5. A potentiometer is used for the comparison of e.m.f. of two cells E_1 and E_2. For cell E_1 the no deflection point is obtained at 20 cm and for E_2 the no deflection point is obtained at 30 cm. The ratio of their e.m.f.'s will be
   (a) 2/3 (b) 1/2 (c) 1 (d) 2

6. A potentiometer consists of a wire of length 4 m and resistance $10\,\Omega$. It is connected to a cell of e.m.f. 2 V. The potential difference per unit length of the wire will be
   (a) 0.5 V/m (b) $2\,V/m$ (c) $5\,V/m$ (d) $10\,V/m$

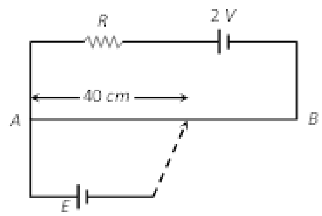
7. If only 2% of the main current is to be passed through a galvanometer of resistance G, then the resistance of shunt will be
   (a) $\frac{G}{50}$ (b) $\frac{G}{49}$ (c) $50\,G$ (d) $49\,G$

8. For a cell of e.m.f. 2V, a balance is obtained for 50 cm of the potentiometer wire. If the cell is shunted by a $2\,\Omega$ resistor and the balance is obtained across 40 cm of the wire, then the internal resistance of the cell is
   (a) $0.25\,\Omega$ (b) 0.50Ω (c) $0.80\,\Omega$ (d) $1.00\,\Omega$

9. A potentiometer wire of length $1m$ and resistance 10 Ω is connected in series with a cell of emf 2V with internal resistance 1 Ω and a resistance box including a resistance R. If potential difference between the ends of the wire is 1 mV, the value of R is
(a) 20000 Ω (b) 19989 Ω (c) 10000 Ω (d) 9989 Ω

10. AB is a potentiometer wire of length 100 cm and its resistance is 10 ohms. It is connected in series with a resistance R = 40 ohms and a battery of e.m.f. 2 V and negligible internal resistance. If a source of unknown e.m.f. E is balanced by 40 cm length of the potentiometer wire, the value of E is

(a) 0.8 V
(b) 1.6 V
(c) 0.08 V
(d) 0.16 V



ANSWER KEY

1. c	2. a	3. c	4. a	5. a	6. a	7. b	8. b	9. b	10. d

Dual Nature of Matter

PHYSICS

1. The threshold frequency for a metallic surface correspond to an energy of 6.2ev and the stopping potential for a radiation incident on this surface is 5v. The incident radiation lies on
(a) Ultra-violet region (b) Infra-red region
(c) Visible region (d) X ray region

2. Two identical photo cathodes receive light of frequencies f_1 and f_2. If the velocities of the photoelectrons (of mass m) coming out are respectively $V_1$and V_2, then
(a) V_1^2-V_2^2 = $\frac{2h}{m}(f_1$-$f_2)$ (b) $V_1 + V_2$ = $\left[\frac{2h}{m}\ (f_1 - f_2\ )\right]^{1/2}$
(c) $V1^2 + V2^2$ = $\frac{2h}{m}(f_1$+$f_2)$ (d) $V_1 - V_2$ = $\left[\frac{2h}{m}\ (f_1 - f_2\ )\right]^{1/2}$

3. A monochromatic light source is placed at a distance d from a metal surface. Photo electrons are ejected at a rate n, and the kinetic energy is being E. If the source is brought nearer to distance $\frac{d}{2}$, the rate and kinetic energy of emitted photo electrons becomes nearly
(a) 2n and 2E (b) 4n and 4E (c) 4n and E (d) n and 4E

4. The work functions of silver and sodium are 4.6 and 2.3 ev respectively. The ratio of the slope of the stopping potential versus frequency plot for silver to that of sodium is
(a) 2:1 (b) 1:2 (c) 2:3 (d) 1:1

5. The work function of a substance is 4.0ev. The longest wavelength of the light that can cause photoelectron emission from the substance is approximately
(a) 310nm (b) 400nm (c) 540nm (d) 220nm.

6. A particle is projected horizontally with a velocity of 10 ms^{-1}. What will be the ratio of de-Broglie wavelength of particle when velocity vector makes an angle 45^o and 60^o with horizontal is.
(a) 1:1 (b)$\sqrt{3}$: 1 (c) 2: $\sqrt{3}$ (d) $\sqrt{2}$: 1

7. λ_1 , λ_2 & λ_3 are the de-Broglie wavelength for a proton, deuteron and alpha particle accelerating through a potential difference of 100v. Their ratio is
(a) 1 : 2 : 2 (b) $\sqrt{2}$: 2 : 1 (c) 1 : $\sqrt{2}$: $\sqrt{2}$ (d) 2$\sqrt{2}$: 2 : 1

8. The ratio of the energies of a moving particle and a photon is 1:100. Their velocities are in the ratio 1: 10, then the ratio of their de-Broglie wavelength is
(a) 5:1 (b) 1:5 (c) 10: 1 (d) 1:10

9. If the kinetic energy of a particle is increased four times, then the percentage decrease in its de-Broglie wavelength will be
(a) 100% (b) 50% (c) 41% (d) 73%

10. After absorbing a slowly moving neutron of mass m_N (momentum ≈0) a nucleus of mass M breaks into two nucleus of mass m_1 and $5m_1$ ($6m_1$ = M + m_N) respectively . If the de-Broglie wavelength of the nucleus with the nucleus $5m_1$ will be

(a) 5λ (b) $\frac{\lambda}{5}$ (c) λ (d) 25λ

ANSWER KEY

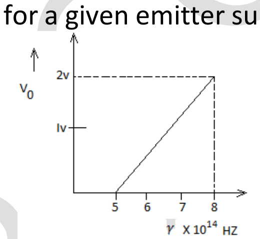
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	a	C	d	a	d	d	a	b	c

1. Light rays of wavelengths 6000A and of photons intensity 39.6 watt/m^2 is incident on a metal surface. If only one percent of photons incident on the surface emit photo electrons , then the number of electrons emitted per second per unit area from the surface will be (h = 6.64 X 10^{-34} JS , C = 3 X 10^8 ms^{-1})
   (a) 12 X 10^{18} (b) 10 X 10^{18} (c) 12 X10^{17} (d) 10 X 10^{17}

2. A metal surface is illuminated by light of two different wavelength 248 nm and 310 nm. The maximum speed of the photoelectrons corresponding to these wavelength are $u_1$and u_2 respectively. If the ratio $u_1 : u_2$ = 2 : 1 and hc = 1240 eVnm , the work function of the metal is nearly
   (a) 3.2 ev (b) 3.7ev (c) 2.5ev (d)2.8ev

3. The threshold wavelength for certain metal is λ_o. When a light of wavelength $\frac{\lambda o}{2}$ is incident on it, the maximum. Velocity of photoelectrons is 10^6 ms^{-1}. If the wave length of the incident radiation is reduced to $\frac{\lambda o}{5}$, then the maximum velocity of the photo electrons in ms^{-1} will be
   (a) 2.5 X 10^6 (b) 5 X 10^6 (c) 4 X 10^6 (d) 2 X 10^6

4. The stopping potential (V_o) – frequency (γ) graph for a given emitter surface is



   (a) $4500A^o$
   (b) $6000A^o$
   (c) $5000A^0$
   (d) $7000A^0$

5. Work function of nickel is 5ev. When a light of wavelength $2000A^o$ falls on it, it emits photoelectrons in the circuit. Then the potential difference necessary to stop the fastest electrons emitted is (h= 6.4 X10^{-34} JS)
   (a) 1.0V (b) 1.75V (c) 1.25V (d) 0.75V

6. If λ_o is the de-Broglie wavelength for a proton accelerated through a potential difference of 100V. The de- Broglie wavelength for α – particle accelerated through the same potential difference is
   (a) $2\sqrt{2}\,\lambda_o$ (b) $\frac{\lambda o}{2}$ (c) $\frac{\lambda o}{2\sqrt{2}}$ (d) $\frac{\lambda o}{\sqrt{2}}$

7. The value of de-Broglie wavelength of an electron moving with a speed of 6.6 X 10^5 ms^{-1} is approximately [h = 6.6 10^{-34} JS, mass of electron = 9 X 10^{-31} kg].
   (a) 11 A^o (b) $111A^o$ (c) 211 A^o (d) 311 A^o

8. The de-Broglie wavelength of a particle moving with a velocity 2.25 X $10^8 ms^{-1}$ is equal to the wavelength of a photon. The ratio of kinetic energy of the particle to the kinetic energy of the photon is (C = 3 X$10^8 ms^{-1}$)
   (a) 1/8 (b) 3/8 (c) 5/8 (d) 7/8

9. Photo of frequency γ has a momentum associated with it. If C is the Velocity of light, the momentum is
   (a) h γ/c (b) γ/c (c) h γc (d)h γ/c^2

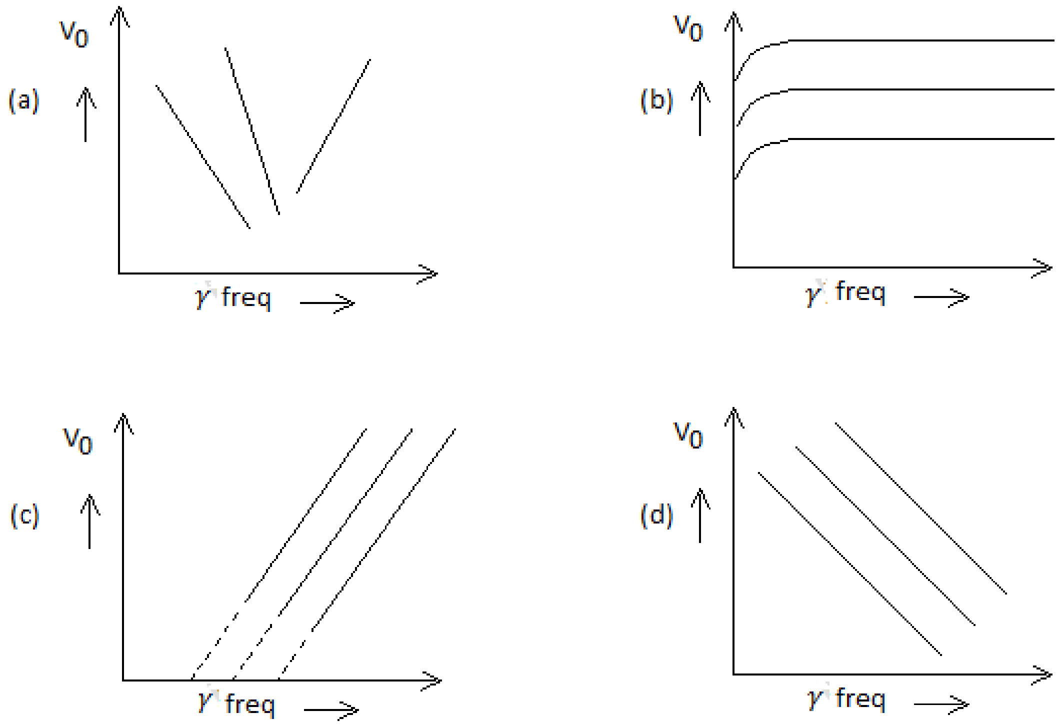
10. A deutron is accelerated through a potential difference of 500V. The potential through which a singly ionized He ion is to be accelerated for same de-Broglie wavelength λ will be
   (a) 50V (b) 250V (c) 500V (d)1000V

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	b	d	b	c	c	a	b	a	b

1. The photo electric cut off voltage in a certain experiment is 1.5 volt. The maximum kinetic energy of photo electrons emitted is
   (a) 2.4×10^{-19}J (b) 24×10^{-19}J (c) 2.4×10^{-18}J (d) 24×10^{-18}J

2. The correct graph between stopping potential (V_0) and incident light frequency (γ) for three different photo metals is



3. The work function for a certain metal is 4.2 ev. This metal is exposed to the light of wavelength 330 nm. Which is the correct statement for the given metal
   (a) Photo electrons are emitted with energy 0.5 ev
   (b) Photo electrons are emitted with energy 1.5 ev
   (c) Photo electrons are emitted with energy 1.25 ev
   (d) There will be no photo electric emission.

4. The work function of a photo metal is 2.1 ev. The light of wave length 4000°A incident on it. The kinetic energy of the photo electrons emitted is
   (a) 0.25 ev (b) 0.5 ev (c) 1 ev (d) 1.5 ev

5. Statement A:- The number of photo electrons emitted, depends on the frequency of the incident radiation
   Statement B:- The kinetic energy of the photo electron depends on the intensity of the incident Light
   (a) A is true and B is false (b) A is false and B is true
   (c) Both A and B are true (d) Both A and B are false

6. Which experiment proved that the electrons behave as a radiation (or) wave?
(a) Rutherford experiment (b) J.J. Thomson Experiment
(c) Davisson and Germer Experiment (d) Millikan's oil drop experiment.

7. An electron is accelerated in a potential difference of 100 V. The corresponding de-Broglie wave length of it is,
(a) 0.1227 nm (b) 1.227 nm (c) 12.27 nm (d) 122.7 nm

8. A proton and an alpha particle are accelerated through a same potential difference. The ratio of the de-Broglie wave length is
(a) 1:$\sqrt{2}$ (b)$\sqrt{2}$:1 (c) 2 $\sqrt{2}$: 1 (d)) 1: 2 $\sqrt{2}$

9. The de-Broglie wave length of a bullet of mass 0.040kg travelling at the speed of 1.0km S^{-1} is (nearly)
(a) 1.7 X 10^{-35}m (b) 1.7 X 10^{-34}m (c) 1.7 X 10^{-33}m (d) 1.7 X 10^{-32}m

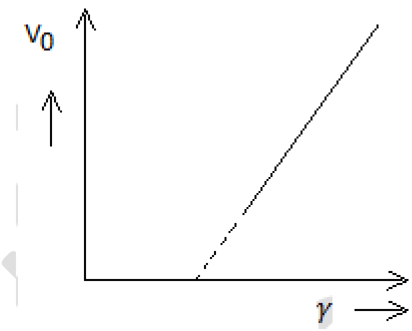
10. The de-Broglie wave length of a neutron at 27 °C is 1.41 A°. The de-Broglie wavelength of another neutron at 327°C will be (nearly)
(a) 4°C (b) 3°C (c) 2°C (d) 1°C

ANSWERS KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	c	d	c	d	c	a	c	a	d

1. A 100 watt sodium lamp radiates energy in all direction. If the wave length of the sodium light is 5890°A, then the energy of each photon is
   (a) 1.11 ev (b) 2.11 ev (c) 3.11 ev (d) 4.11 ev

2. In the graph between stopping potential (V_0) and incident light frequency (γ) for a photo metal, which is the correct statement



   (a) Slope gives $\left(\frac{h}{e}\right)$ value and the X-axis intercept gives KE of the photo electron
   (b) Slope gives threshold frequency and the X-axis intercept gives $\left(\frac{h}{e}\right)$ value
   (c) Slope gives $\left(\frac{h}{e}\right)$ value and the X-axis intercept gives threshold frequency
   (d) Slope gives KE of the electron and the X-axis intercept gives Intensity of the incident light

3. The threshold frequency of a photo metal is γ_0. The light of frequency $2\gamma_0$ incident on the metal, the maximum velocity of the photo electron is V. If light of frequency $5\gamma_0$ incident on it, the maximum velocity of the photo electron will be
   (a) V (b) 2V (c) 3V (d) 4V

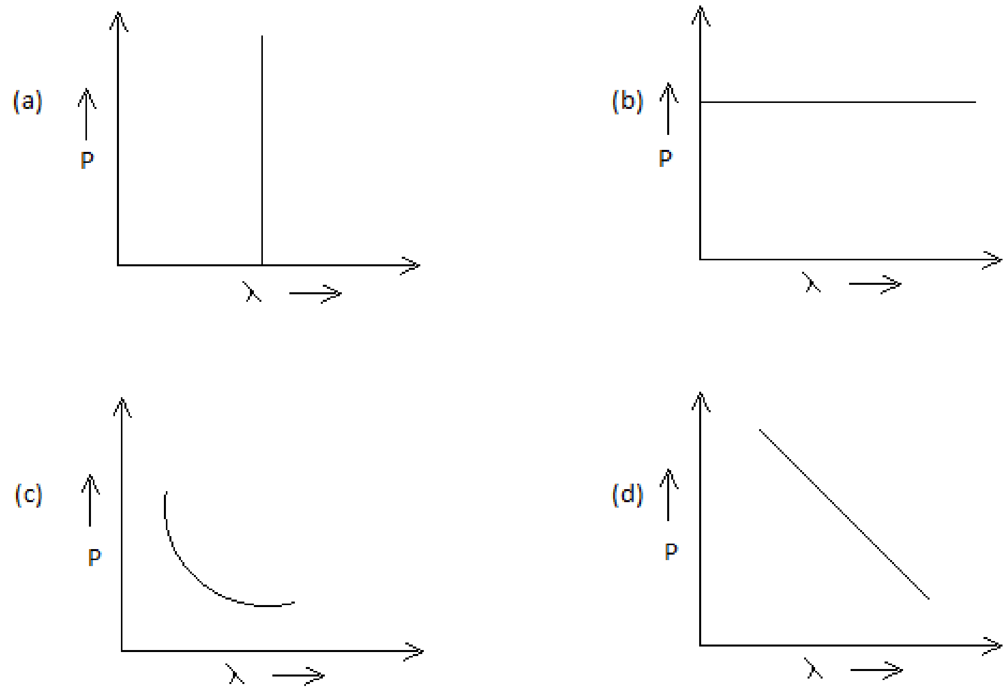
4. Light of two different frequencies whose photons have energies 1eV and 2.5 ev respectively, successively illuminate a metallic surface whose work function is 0.5 ev. Ratio of maximum speeds of emitted electrons will be
   (a) 1:4 (b) 1:1 (c) 1:5 (d) 1:2

5. Maximum velocity of the photo electron emitted by a metal is 1.8 X$10^6 ms^{-1}$. Take the value of specific charge of the electron is 1.8 X 10^{11}Ckg^{-1}. Then the stopping potential in volt is
   (a) 1 (b) 3 (c) 9 (d) 6

6. An electron of mass m_e and a proton of mass m_p are moving with the same speed. The ratio of their de-Broglie's wavelengths $\frac{\lambda e}{\lambda p}$ is
   (a) 1 (b) 1836 (c) $\frac{1}{1836}$ (d) 918

7. The kinetic energy of an electron gets tripled, then the de Broglie wave length associated with it changes by a factor
   (a) $^1/_3$ (b) $\sqrt{3}$ (c) $^1/_{\sqrt{3}}$ (d) 3

8. The graph between de Broglie wave length (λ) and the linear momentum of the particle (P) is



9. If the velocity of the particle reduced to one third, then the percentage increase in its de Broglie Wavelength is
(a) 100% (b) 200% (c) 300% (d)400%

10. A stationary shell of mass 5m explodes into two parts and their masses are in the ratio 2:3, then the ratio of their de-broglie wavelengths is
(a) 2:3 (b) 3:2 (c) 9:4 (d) 1:1

ANSWERS KEY

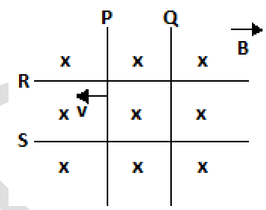
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
b	C	b	d	c	b	c	c	b	d

Electromagnetic Induction

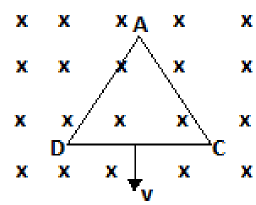
PHYSICS

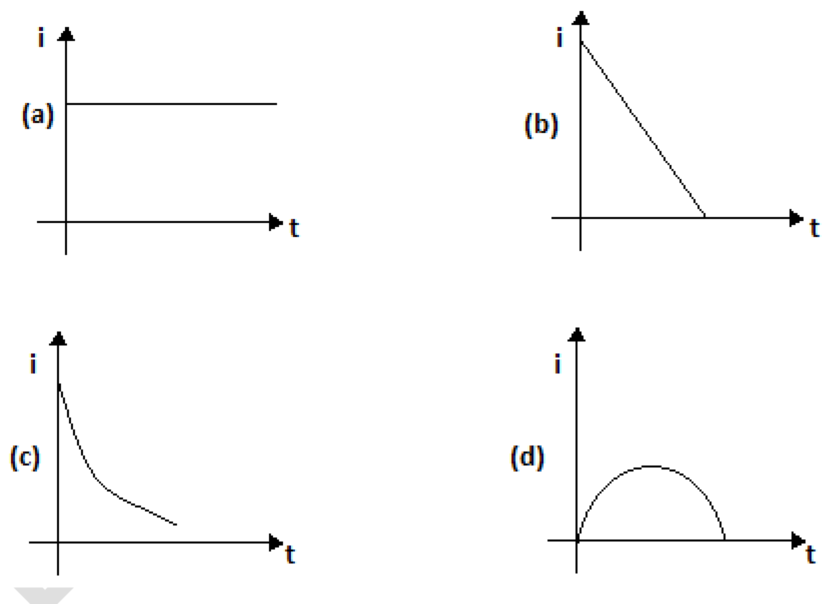
1. Two circular coils A and B are facing each other as shown in figure. The current I through A can be altered:
(a) There will be repulsion between A and B if i is increased
(b) There will be attraction between A and B if i is increased
(c) There will be neither attraction nor repulsion when I is changed
(d) attraction or repulsion between A and B depends on the direction of current. It does not depend whether the current is increased or decreased

2. Two identical conductors P and Q are placed on two frictionless rails R and S in a uniform magnetic field directed into the plane. If P is moved in the direction shown in figure with a constant speed then rod Q:
(a) Will be attracted towards P
(b) Will be repelled away from P
(c) Will remain stationary
(d) May re repelled or attracted towards P

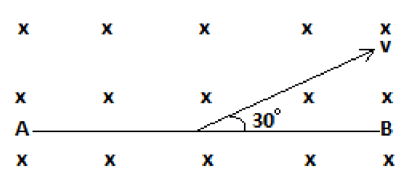


3. An equilateral triangular loop ADC having some resistance is pulled with a constant velocity v out of a uniform magnetic field directed into the paper. At time t = 0, side DC of the loop is at edge of the magnetic field. The induced current (i) versus time (t) graph will be as:

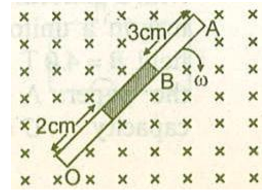




4. A conducting rod AB of length l = 1 m is moving at a velocity v = 4 m/s making an angle 30° with its length. A uniform magnetic field B = 2 T exists in a direction perpendicular to the plane of motion. Then:
(a) $V_A - V_B = 8V$ (b) $V_A - V_B = 4V$
(c) $V_B - V_A = 8V$ (d) $V_B - V_A = 4V$

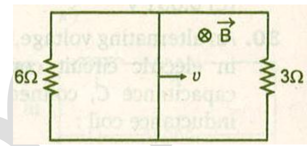


5. A rod of length 10 cm made up of conducting and non – conducting material (shaded part is non – conducting). The rod is rotated with constant angular velocity 10 rad/s about point O, in constant magnetic field of 2 T as shown in the figure. The induced emf between the point A and B of rod will be:



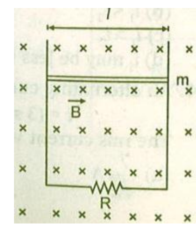
(a) 0.029V (b) 0.1V
(c) 0.051 V (d) 0.064 V

6. A rectangular loop with a sliding connector of length l = 1.0 m is situated in a uniform magnetic field B = 2T perpendicular to the plane of loop. Resistance of connector is r = 2Ω. Two resistance of 6 Ω and 3 Ω are connected as shown in figure. The external force required to keep the connector moving with a constant velocity v = 2m/s is:



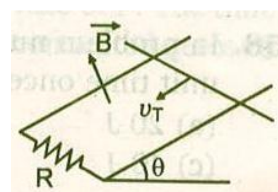
(a) 6 N (b) 4 N (c) 2 N (d) 1 N

7. A horizontal wire is free to slide on the vertical rails of a conducting frame as shown in figure. The wire has a mass m and length l. Resistance of the circuit is R. If a uniform magnetic field B is directed perpendicular to the frame, the terminal speed of the wire
as it falls under the force of gravity is :



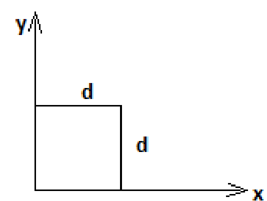
(a) $\frac{mgR}{Bl}$ (b) $\frac{mgl}{BR}$ (c) $\frac{B^2l^2}{mgR}$ (d) $\frac{mgR}{B^2l^2}$

8. A copper rod of mass m slides under gravity on two smooth parallel rails l distance apart and set at an angle θ to the horizontal. At the bottom, the rails are joined by a resistance R. There is a uniform magnetic field perpendicular to the plane of the rails. The terminal velocity of the rod is:



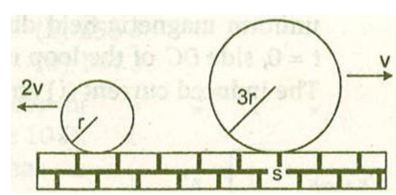
(a) $\frac{mgR\cos\theta}{B^2l^2}$ (b) $\frac{mgR\sin\theta}{B^2l^2}$
(c) $\frac{mgR\tan\theta}{B^2l^2}$ (d) $\frac{mgR\cot\theta}{B^2l^2}$

9. The magnetic field in a region is given by $\vec{B} = B_0\left(\frac{x}{a}\right)\hat{k}$. A square loop of a side d is placed with its edges along the x and y axis. The loop is moved with a constant velocity $\vec{v} = v_0\,\hat{\imath}$. The emf induced in the loop is :



(a) B_0v_0d (b) $\frac{B_0V_0d^2}{2a}$
(c) $\frac{B_0V_0d^3}{a^2}$ (d) $\frac{B_0V_0d^2}{a}$

10. Two conducting rings P and Q of radius r and 3r move in opposite directions with velocities 2v and v respectively on a conducting surface S. There is a uniform magnetic field of magnitude B perpendicular to the plane of the rings. The potential difference between the highest points of the two rings is: [Assume only transilatory motion]



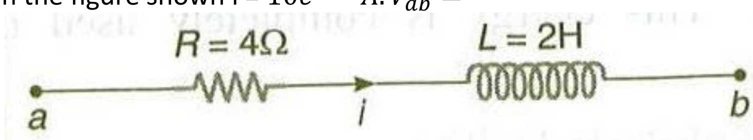
(a) Zero (b) 2 Brv
(c) 6 Brv (d) 10 Brv

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	a	b	b	c	c	d	b	d	d

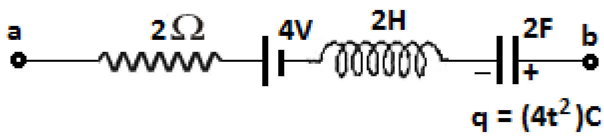
1. The magnetic flux threading a metal ring varies with time t according to $\phi_B = 3(at^3 - bt^3)\,T - m^2$ with a = 2.00 s^{-3} and b = 6.00 s^{-2}. The resistance of the ring is 3.0 Ω. The maximum current induced in
the right during the interval from t = 0 to t = 2.0 s is.
(a) 6A (b) 3A (c) 2A (d) 1A

2. In the figure shown i = $10e^{-4t}\ A. V_{ab} =$



(a) $40\ e^{-4t}$ (b) $-40\ e^{-4t}$ (c) $80\ e^{-4t}$ (d) $-80\ e^{-4t}$

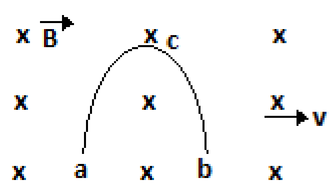
3. In the figure shown $V_{ab}\ at\ t = 1s\ is$



(a) 30 V (b) – 30 V (c) 20 V (d) – 20 V

4. A magnetic flux through a stationary loop with a resistance R varies during the time interval τ as ϕ = at $(\tau - t)$.
The amount of the heat generated in the loop during that time is
(a) $\frac{a\tau^2}{2R}$ (b) $\frac{a^2\tau^3}{3R}$ (c) $\frac{2a^2\tau^3}{3R}$ (d) $\frac{a\tau}{3R}$

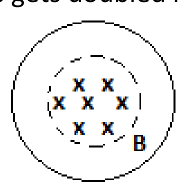
5. A semi – circular conducting ring acb of radius R moves with constant speed v in a plane perpendicular to uniform magnetic field B as shown in figure. Identify the correct statement



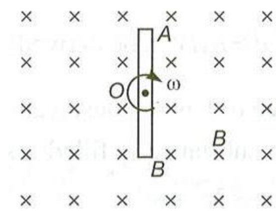
(a) $V_a - V_c = BRv$
(b) $V_a - V_b = 0$
(c) $V_b - V_c = BRv$
(d) None of these

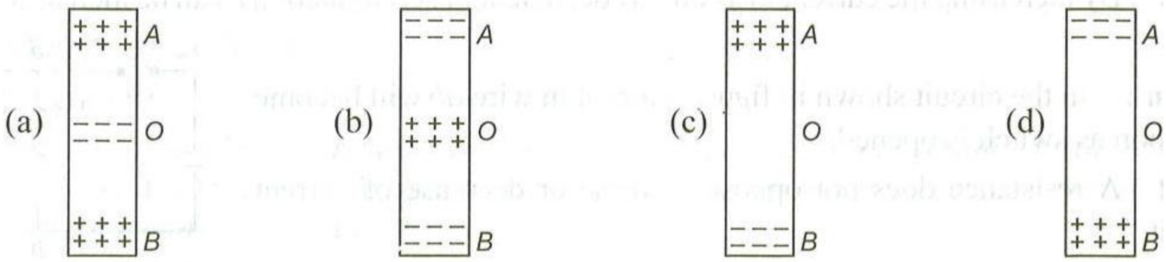
6. The figure shows a conducting ring of radius R. A uniform steady magnetic field B lies perpendicular to the plane of the ring in a circular region of radius r ($< R$). If the resistance per unit length of the ring is λ, then the current induced in the ring when its radius gets doubled is

(a) $\frac{BR}{\lambda}$ (b) $\frac{2BR}{\lambda}$
(c) zero (d) $\frac{Br^2}{4R\lambda}$

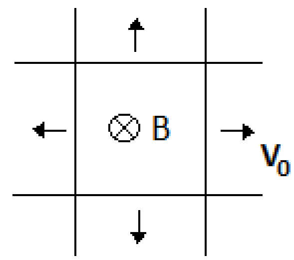


7. A rod is rotating with a constant angular velocity ω about point O (its centre) in a magnetic field B as shown. Which of the following figure correctly shows the distribution of charge inside the rod?





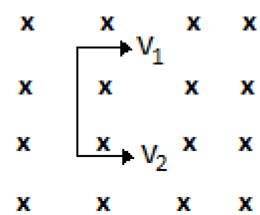
8. Two parallel long straight conductors lie on a smooth plane surface. Two other parallel conductors rest on them at right angles so as to form a square of side a. A uniform magnetic field B exists at right angles to the plane containing the conductors. Now conductors start moving outward with a constant velocity v_0 $at\ t = 0$. Then induced current in the loop at any time t is (λ is resistance per unit length of the conductors)



(a) $\frac{aBv_0}{\lambda(a+v_0t)}$ (b) $\frac{aBv_0}{2\lambda}$

(c) $\frac{Bv_0}{\lambda}$ (d) $\frac{Bv_0}{2\lambda}$

9. In the figure magnetic field points into the plane of paper and the conducting rod of length l is moving in this field such that the lowest point has a velocity v_1 and the topmost point has the velocity v_2 $(v_2 > v_1)$. The emf induced is given by



(a) $Bv_1\ l$ (b) $Bv_2\ l$

(c) $\frac{1}{2}B(v_1 + v_2)l$ (d) $\frac{1}{2}B(v_2 - v_1)l$

10. Electric charge q is distributed uniformly over a rod of length l. The rod is placed parallel to a long wire carrying a current i. The separation between the rod and the wire is a. The force needed to move the rod along its length with a uniform velocity v is

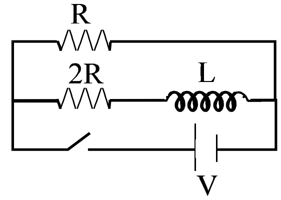
(a) $\frac{\mu_0 iqv}{2\pi a}$ (b) $\frac{\mu_0 iqv}{4\pi a}$ (c) $\frac{\mu_0 iqvl}{2\pi a}$ (d) $\frac{\mu_0 iqvl}{4\pi a}$

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
d	b	b	b	b	c	a	c	c	a

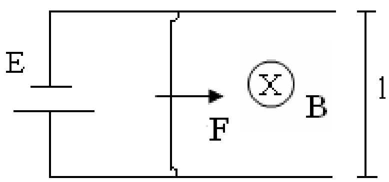
1) A current of 2A is increasing at a rate of 4 A/s through a coil of inductance 2H. The energy stored in the inductor per unit time is
a) 2 J/s b) 1 J/s c) 16 J/s d) 4 J/s

2. The ratio of time constant in build up and decay for the circuit shown in the figure is



a) 1 : 1 b) 3 : 2 c) 2 : 3 d) 1 : 3

For Questions 3 to 5
B is in the vertically downward direction. Resistance of rails, battery is negligible. Mass of slider is m, its resistance is R. Coefficient of friction between the slider and the rails is □.

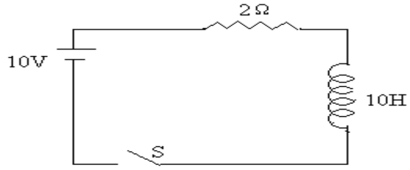


3. Minimum value of F = F_{min} to move the slider rightwards is
a) $\frac{BEl}{R} - \mu mg$ b) $\frac{BEl}{R} + \mu mg$ c) $\frac{BEl}{2R} - \mu mg$ d) $\frac{BEl}{2R} + \mu mg$

4. If F = $2F_{min}$ is applied on the slider, steady state velocity of the slider v_0 is
a) $\frac{\mu mgR - BEl}{4B^2l^2}$ b) $\frac{\mu mgR - BEl}{B^2l^2}$ c) $\frac{\mu mgR + BEl}{4B^2l^2}$ d) $\frac{\mu mgR - BEl}{B^2l^2}$

5. Thermal power generated in the slider is
a) $\frac{2}{RB^2l^2}[\mu mgR + EBl]^2$ *b) $\frac{1}{RB^2l^2}[\mu mgR + 2EBl]^2$
c) $\frac{2}{RB^2l^2}[\mu mgR - EBl]^2$ d) $\frac{12}{RB^2l^2}[\mu mgR + 2EBl]^2$

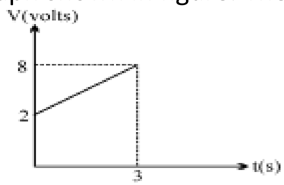
6. An R.L circuit is shown. At time t = 0 the switch S is closed. The time taken for the magnetic energy to reach 25% of the maximum value is



a) $\frac{\ln 4}{5}$ 2) $\frac{\ln 2}{5}$ c) 5ln 4 d) ln 32

7. The current in a coil of self inductance 2H is increasing with time t according to $I = 2\sin t^2$ A . The amount of energy spent during the period when the current changes from 0 to 2A is
   a) 4 J b) 8 J c) 2 J 4) 1 J

8. A circuit element is placed in a closed box. At time t=0, constant current generator supplying a current of 1 amp, is connected across the box. Potential difference across the box varies according to graph shown in figure. The element in the box is



   a) Resistance of 2 Ω b) Battery of emf 6V c) Inductance of 2H d) Capacitance of 0.5F

9. An electron is moving in a circular orbit of radius R with an angular acceleration α . At the centre of the orbit is kept a conducting loop of radius r, (r <<R). The e.m.f induced in the smaller loop due to the motion of the electron is
   a) Zero b) $\frac{\mu_0 e r^2}{4R}\alpha$ c) $\frac{\mu_0 e r^2}{4\pi R}\alpha$ d) $\frac{\mu_0 e r^2}{2\pi R}\alpha$

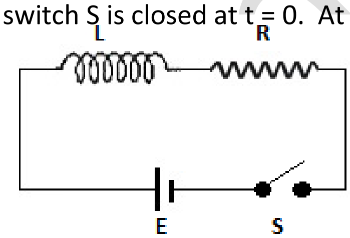
10. A metallic rod of length L and mass M is moving under the action of two unequal forces F_1 and F_2 (directed opposite to each other) acting at its ends along its length. Ignore gravity and any external magnetic field. If specific charge of electrons is (e/m), then the potential difference between the ends of the rod is steady state must be
   a) $|F_1 - F_2|mL/eM$ b) $\frac{|F_1-F_2|mL}{eM}$ c) $[mL/eM]ln[F_1/F_2]$ d) Zero

1	2	3	4	5	6	7	8	9	10
c	b	b	d	b	d	a	d	b	a

1. Two coils have a mutual inductance of 0.005 H. The current changes in the first coil according to equation I = I_0 sin ωt , where $I_0 = 10\ A\ and\ \omega = 100\pi\ rad/s.$ The maximum value of emf (in volt) in the second coil is
   (a) 2π (b) 5π (c) π (d) 4π

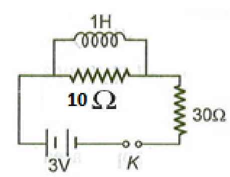
2. In a transformer the output current and voltage are respectively 4 A and 20 V. If the ratio of number of turns in the primary to secondary is 2 : 1. The input current and voltage is
   (a) 2 A and 40 V (b) 8 A and 10 V (c) 4 A and 10 V (d) 8 A and 40 V

3. In the circuit shown in figure, L = 10H, R = 5 Ω E = 15 V. The switch S is closed at t = 0. At t = 2 s, the current in the circuit is



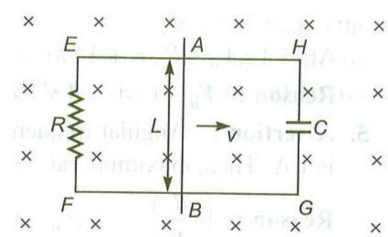
   (a) $3\left(1 - \frac{1}{e}\right) A$ (b) $3\left(1 - \frac{1}{e^2}\right) A$
   (c) $3\left(\frac{1}{e}\right) A$ (d) $3\left(\frac{1}{e^2}\right) A$

4. In figure, final value of current in 10Ω resistor, when plug of key K is inserted is



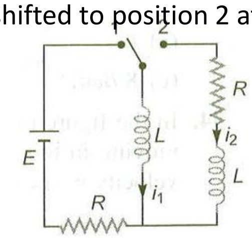
   (a) $\frac{3}{10}\ A$ (b) $\frac{3}{20}\ A$
   (c) $\frac{3}{11}\ A$ (d) zero

5. A conducting rod is moving with a constant velocity v over the parallel conducting rails which are connected at the ends through a resistor R and capacitor C as shown in the figure. Magnetic field B is into the plane.
   Consider the following statements
   (i) Current in loop AEFBA is anticlock wise
   (ii) Current in loop AEFBA is clock wise
   (iii) Current through the capacitor is zero
   (iv) Energy stored in the capacitor is $\frac{1}{2} CB^2L^2v^2$
   Which of the following options is correct?



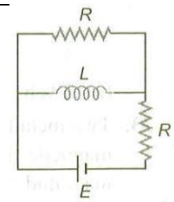
   (a) statement (i) and (iii) are correct (b) statement (ii) and (iv) are correct
   (c) statement (i), (iii) and (iv) are correct (d) All the statements are correct

6. In figure, the switch is in the position 1for a long time, then the switch is shifted to position 2 at t = 0. At this instant the value of $i_1\ and\ i_2$ are



   (a) $\frac{E}{R}, 0$ (b) $\frac{E}{R}, \frac{-E}{R}$
   (c) $\frac{E}{2R}, \frac{-E}{2R}$ (d) 0, 0

7. The figure shows an L – R circuit, the time constant for the circuit is

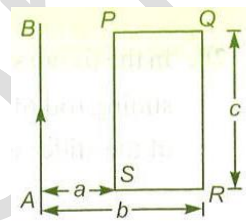


(a) $\frac{L}{2R}$ (b) $\frac{2L}{R}$
(c) $\frac{2R}{L}$ (d) $\frac{R}{2L}$

8. An L – R circuit is connected to a battery at time t = 0. The energy stored in the inductor reaches half its maximum value at time

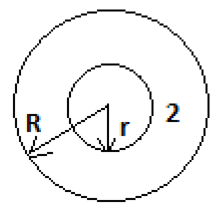
(a) $\frac{R}{L}\ In\left[\frac{\sqrt{2}}{\sqrt{2}-1}\right]$ (b) $\frac{L}{R}\ In\left[\frac{\sqrt{2}-1}{\sqrt{2}}\right]$ (c) $\frac{L}{R}\ In\left(\frac{\sqrt{2}}{\sqrt{2}-1}\right)$ (d) $\frac{R}{L}\ In\left[\frac{\sqrt{2}-1}{\sqrt{2}}\right]$

9. AB is an infinitely long wire placed in the plane of rectangular coil of dimensions as shown in the figure.
The mutual inductance of wire AB and coil PQRS is



(a) $\frac{\mu_0 b}{2\pi}\ In\ \frac{a}{b}$ (b) $\frac{\mu_0 c}{2\pi}\ In\ \frac{b}{a}$
(c) $\frac{\mu_0\ abc}{2\pi\ (b-a)^2}$ (d) None of these

10. The mutual inductance of the two concentric circular coils 1 and 2 of radii 'R' and 'r' having $n_1$and n_2 turns respectively is

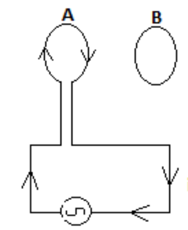


(a) $\frac{\mu_0 n_1 n_2 \pi i r^2}{2R}$ (b) $\frac{\mu_0 n_1 n_2 \pi i R^2}{2r}$
(c) $\frac{\mu_0 n_1 n_2 \pi i R}{2r}$ (d) $\frac{\mu_0 n_1 n_2 \pi i r}{2R}$

ANSWER KEY

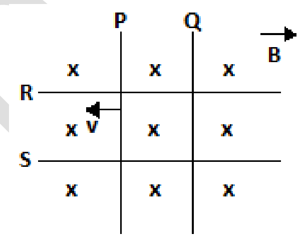
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
b	a	a	d	c	b	d	c	b	a

1. Two circular coils A and B are facing each other as shown in figure. The current I through A can be altered:



(a) There will be repulsion between A and B if iis increased
(b) There will be attraction between A and B if iis increased
(c) There will be neither attraction nor repulsion when I is changed
(d) attraction or repulsion between A and B depends on the direction of current.
It does not depend whether the current is increased or decreased

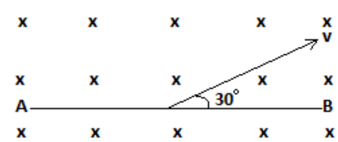
2. Two identical conductors P and Q are placed on two frictionless rails R and S in a uniform magnetic field directed into the plane. If P is moved in the direction shown in figure with a constant speed then rod Q:



(a) Will be attracted towards P
(b) Will be repelled away from P
(c) Will remain stationary
(d) May re repelled or attracted towards P

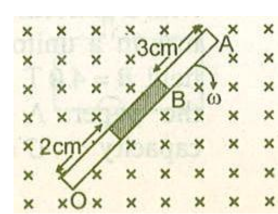
3. A thin wire of length 2m is perpendicular to the xy plane. It is moved with velocity $\vec{v} = (2\hat{i}+3\hat{j}+\hat{k})\,m/s$ through a region of magnetic induction $\vec{B} = (\hat{i}+2\hat{j})\ Wb/m^2$. Then potential difference induced between the ends of the wire is
a) 2 V b) 4 V c) 0 V d) 1V

4. A conducting rod AB of length l = 1 m is moving at a velocity v = 4 m/s making an angle 30° with its length. Auniform magnetic field B = 2 T exists in a direction perpendicular to the plane of motion. Then:



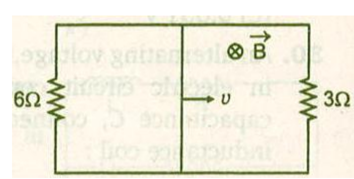
(a) $V_A - V_B = 8V$ (b) $V_A - V_B = 4V$
(c) $V_B - V_A = 8V$ (d) $V_B - V_A = 4V$

5. A rod of length 10 cm made up of conducting and non – conducting material (shaded part is non – conducting). The rod is rotated with constant angular velocity 10 rad/s about point O, in constant magnetic field of 2 T as shown in the figure. The induced emfbetween the point A and B of rod will be:



(a) 0.029V (b) 0.1V
(c) 0.051 V (d) 0.064 V

6. A rectangular loop with a sliding connector of length l = 1.0 m is situated in a uniform magnetic field B = 2T perpendicular to the plane of loop. Resistance of connector is r = 2Ω. Two resistance of 6Ω and 3 Ω are connected as shown in figure. The external force required to keep the connector moving with a constant velocity v = 2m/s is:

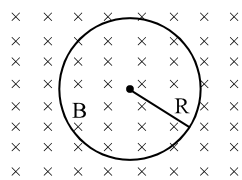


(a) 6 N (b) 4 N (c) 2 N (d) 1 N

7. A closed planar wire loop of area A and arbitrary shape is placed in a uniform magnetic field of magnitude B, with its plane perpendicular to magnetic field. The resistance of the wire loop is R. The loop is now turned upside down by 180° so that its plane again becomes perpendicular to the magnetic field. The total charge that must have flowed through the wire ring in the process is equal to

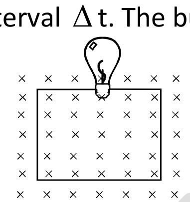
   a) AB/R b) Zero c) 2AB/R d)AB/2R

8. A conducting loop of radius R is present in a uniform magnetic field B perpendicular the plane of the ring. If radius R varies with time 't' as $R = R_0 + t$. The e.m.f induced in the loop is



   a) $2\pi(R_0 + t)B$ clockwise b) $\pi(R_0 + t)B$ clockwise c) $2\pi(R_0 + t)B$ anticlockwise d) Zero

9. A square wire loop of 10.0 cm side lies at right angles to a uniform magnetic field of 20T. A 10 V light bulb is in a series with the loop as shown in the figure. The magnetic field is decreasing steadily to zero over a time interval Δt. The bulb will shine with full brightness if Δt is equal to



   a) 20ms b) 0.02ms c) 2 ms d) 0.2ms

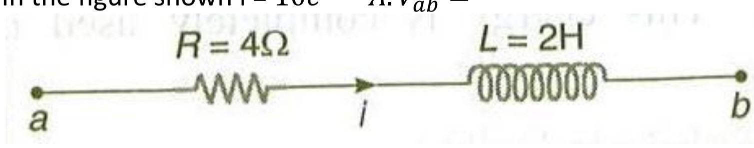
10. A long metal bar of 30 cm length is aligned along a north south line and moves eastward at a speed of 10 ms^{-1}. A uniform magnetic field of 4.0 T points vertically downwards. If the south end of the bar has a potential of 0 V, the induced potential at the north end of the bar is

    a) +12V b) -12V c) 0V d) Cannot be determined since the circuit is not closed

ANSWER KEY

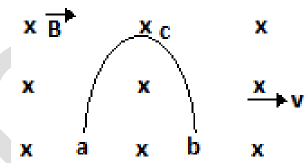
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	a	a	b	c	c	c	c	a	a

1. In the figure shown i = $10e^{-4t}\ A. V_{ab} =$



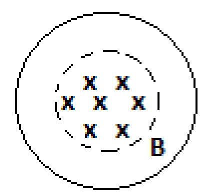
(a) $40\ e^{-4t}$ (b) $-40\ e^{-4t}$ (c) $80\ e^{-4t}$ (d) $-80\ e^{-4t}$

2. A semi – circular conducting ring acb of radius R moves with constant speed v in a plane perpendicular to uniform magnetic field B as shown in figure. Identify the correct statement



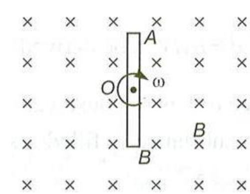
(a) $V_a - V_c = BRv$
(b) $V_a - V_b = 0$
(c) $V_b - V_c = BRv$
(d) None of these

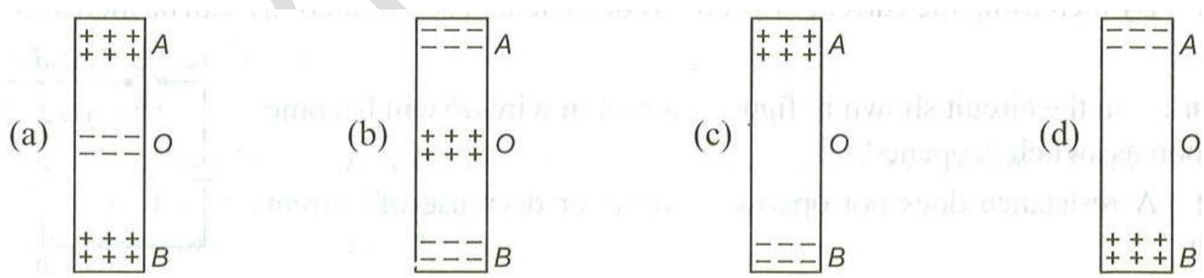
3. The figure shows a conducting ring of radius R. A uniform steady magnetic field B lies perpendicular to theplane of the ring in a circular region of radius r ($< R$). If the resistance per unit length of the ring is λ, then the current induced in the ring when its radius gets doubled is



(a) $\frac{BR}{\lambda}$ (b) $\frac{2BR}{\lambda}$
(c) zero (d) $\frac{Br^2}{4R\lambda}$

4. A rod is rotating with a constant angular velocity ω about point O (its centre) in a magnetic field B as shown. Which of the following figure correctly shows the distribution of charge inside the rod?

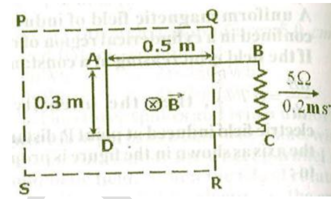




5. A thin wire of length 2m is perpendicular to the x - y plane. It is moved with velocity$\vec{V} = (2\hat{\imath} + 3\hat{\jmath} + \hat{k})m/s$through a region of magnetic induction $\vec{B} = (\hat{\imath} + 2\hat{\jmath})Wb/m^2$. Then potential difference induced between the ends of the wire is
a) 2V b) 4V c) 0V d) 5V

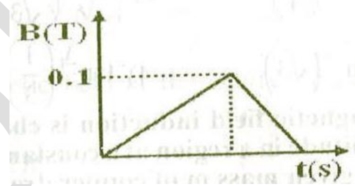
6. A coil of1200 turns and mean area of 500 cm^2 is held perpendicular to a uniform magnetic field of induction 4×10^{-4} T. The resistance of the coil is 20 ohms. When the coil is rotated through 180^0 in the magnetic field in 0.1 seconds the average electric current (in mA) induced is:
(a) 12 (2) 24 (c) 36 (d) 48

7. A circuit ABCD is held perpendicular to the uniform magnetic field of B = 5×10^{-2} T extending over the region PQRS and directed into the plane of the paper. The circuit is moving out of the field at u uniform speed of 0.2ms^{-1} for 1.5s. During this time, the current in the 5Ω resistor is



(a). 0.6 mA from B to C (b). 0.9 mA from B to C
(c) 0.9 mA from C to B (d) 0.6 mA from C to B

8. A closed loop of cross-sectional area 10^{-2}m^2 which has inductance L = 10 mH and negligible resistance is placed in a time varying magnetic field. Figure shows the variation of B with time for the interval 4 s. The field is perpendicular to the plane of the loop (given at t=0, B=0, I=0). The value of the maximum current induced in the loop is



(a) 0.1 mA (b) 10mA (c) 100mA (d) 20mA

9. A rectangular loop of sides 10cm and 5cm with a cut is stationary between the pole pieces of an electromagnet. The magnetic field of the magnet is normal to the loop. The current feeding the electromagnet is reduced so that the field decreases from its initial value of 0.3 T at the rate of 0.02Ts^{-1}. If the cut is joined and the loop has a resistance of 2.0Ω, the power dissipated by the loop as heat is (in nW)
a) 5 b) 4 c) 3 d) 2

10. A horizontal magnetic field B is produced across a narrow gap between the two square iron pole pieces. A closed square loop of side a, mass m and resistance R is allowed to fall with the top of the loop in the field. The loop attains a terminal velocity equal to

(a) $\frac{Rmg}{B^2a^2}$ (b) $\frac{\mu_0}{4\pi}\frac{Rmg}{Ba^2}$ (c)) $\frac{mgB}{Ra^2}$ (d) $\frac{\mu_0}{4\pi}\frac{RmB}{Ba^2}$

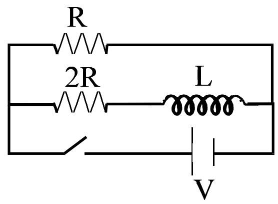
ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
b	b	c	a	a	b	a	c	a	a

1) A current of 2A is increasing at a rate of 4 A/s through a coil of inductance 2H. The energy stored in the inductor per unit time is

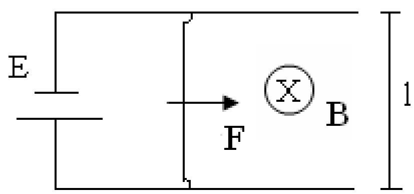
a)2 J/s b) 1 J/s c)16 J/s d)4 J/s

2. The ratio of time constant in build up and decay for the circuit shown in the figure is



a) 1:1 b) 3:2 c) 2:3 d) 1:3

3. B is in the vertically downward direction. Resistance of rails, battery is negligible. Mass of slider is m, its resistance is R. Coefficient of friction between the slider and the rails is ⍰.



Minimum value of F = F_{min} to move the slider rightwards is

a) $\frac{BEl}{R} - \mu mg$ b) $\frac{BEl}{R} + \mu mg$ c) $\frac{BEl}{2R} - \mu mg$ d) $\frac{BEl}{2R} + \mu mg$

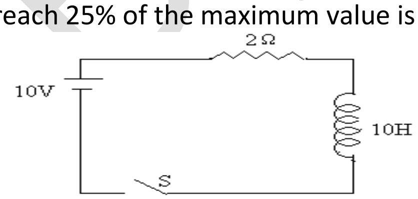
4. The coefficient of mutual inductance of two circuits A and B is 3 mH and their respective resistances are 10 Ω and 4Ω. The current that should change in 0.02 s in circuit A, so that the induced current in B should be 0.006 A is

(a) 0.24 A (b) 1.6 A (c) 0.18 A (d) 0.16 A

5. When a loop moves towards a stationary magnet with a speed v, the induced emf in the loop is E. If the magnet also moves away from the loop with the same speed, the emf induced in the loop is

a) E b) 2E c) E/2 d) Zero

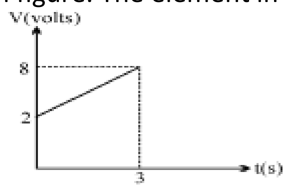
6. An R.L circuit is shown. At time t = 0 the switch S is closed. The time taken for the magnetic energy to reach 25% of the maximum value is



a) $\frac{\ln 4}{5}$ b) $\frac{\ln 2}{5}$ c) 5ln 4 d) ln 32

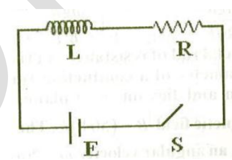
7. The current in a coil of self inductance 2H is increasing with time t according to $I = 2\sin t^2$ A .The amount of energy spent during the period when the current changes from 0 to 2A is
   a) 4 J b) 8 J c) 2 J 4) 1 J

8. A circuit element is placed in a closed box. At time t=0, constant current generator supplying a current of 1 amp, is connected across the box. Potential difference across the box varies according to graph shown in figure. The element in the box is



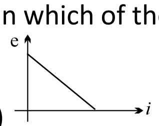
   a) Resistance of 2 Ω b) Battery of emf 6V c) Inductance of 2H d) Capacitance of 0.5F

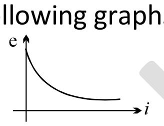
9. In the circuit shown in figure, switch S is closed at time t= 0. The charge that passes through the battery in one time constant is

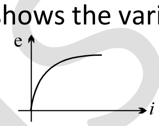


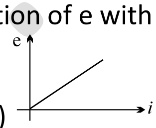
   (a) $\frac{eR^2E}{L}$ (b) $E\left[\frac{L}{R}\right]$ (c) $\frac{EL}{eR^2}$ (d) $\frac{eL}{ER}$

10. In an L-R circuit connected to a battery of constant e.m.f. E switch S is closed at time t = 0. If e denotes the magnitude of induced e.m.f. across inductor and i the current in the circuit at any time t. Then which of the following graphs shows the variation of e with i ?

a) 

b) 

c) 

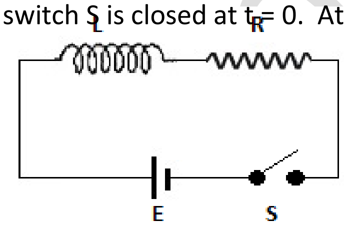
d) 

1	2	3	4	5	6	7	8	9	10
c	b	b	d	d	d	a	d	c	a

1. Two coils have a mutual inductance of 0.005 H. The current changes in the first coil according to equation I = $I_0 \sin \omega t$, where $I_0 = 10\ A\ and\ \omega = 100\pi\ rad/s.$ The maximum value of emf (in volt) in the second coil is
(a) 2π (b) 5π (c) π (d) 4π

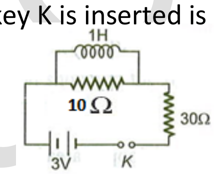
2. In an inductance coil the current increases from zero to 6 A in 0.3 second by which an induced e.m.f. of 60 V is produced in it. The value of coefficient of self-induction of coil is
(a) 1 H (b) 1.5 H (c) 2 H (d) 3 H

3. In the circuit shown in figure, L = 10H, R = 5 Ω E = 15 V. The switch S is closed at t = 0. At t = 2 s, the current in the circuit is



(a) $3\left(1-\frac{1}{e}\right)A$ (b) $3\left(1-\frac{1}{e^2}\right)A$
(c) $3\left(\frac{1}{e}\right)A$ (d) $3\left(\frac{1}{e^2}\right)A$

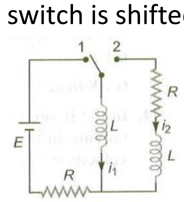
4. In figure, final value of current in 10Ω resistor, when plug of key K is inserted is



(a) $\frac{3}{10}\ A$ (b) $\frac{3}{20}\ A$
(c) $\frac{3}{11}\ A$ (d) zero

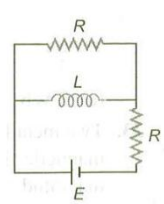
5. The time constant of an inductor is τ_1. When a pure resistor of RΩ is connected in series with it, the time constant is found to decrease to τ_2. The internal resistance of the inductor is
(a) $\frac{R\tau_2}{\tau_1-\tau_2}$ (b) $\frac{R\tau_1}{\tau_1-\tau_2}$ (c) $\frac{R(\tau_1-\tau_2)}{\tau_1}$ (d) $\frac{R(\tau_1-\tau_2)}{\tau_2}$

6. In figure, the switch is in the position 1for a long time, then the switch is shifted to position 2 at t = 0. At this instant the value of $i_1\ and\ i_2$ are



(a) $\frac{E}{R}, 0$ (b) $\frac{E}{R}, \frac{-E}{R}$
(c) $\frac{E}{2R}, \frac{-E}{2R}$ (d) 0, 0

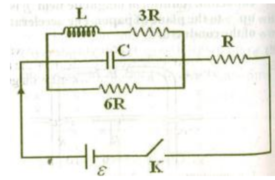
7. The figure shows an L – R circuit, the time constant for the circuit is



(a) $\frac{L}{2R}$ (b) $\frac{2L}{R}$
(c) $\frac{2R}{L}$ (d) $\frac{R}{2L}$

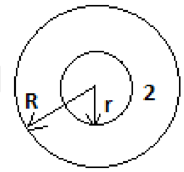
8. Eddy currents are produced in a material when it is
a) Heated b) Placed in a time varying magnetic field
c) Placed in a electric field d) Placed in a uniform magnetic field

9. In the given circuit diagram, key K is switched on at t=0. The ratio of current i through the cell at t=0 to that at t=∞ will be



(a) 3:1 (b) 1:3
(c) 1:2 (d) 2:1

10. The mutual inductance of the two concentric circular coils 1 and 2 of radii 'R' and 'r' having n_1 and n_2 turns respectively is



(a) $\frac{\mu_0 n_1 n_2 \pi i r^2}{2R}$ (b) $\frac{\mu_0 n_1 n_2 \pi i R^2}{2r}$

(c) $\frac{\mu_0 n_1 n_2 \pi i R}{2r}$ (d) $\frac{\mu_0 n_1 n_2 \pi i r}{2R}$

ANSWER KEY

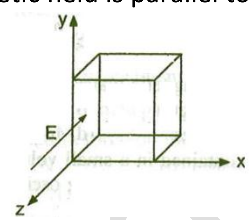
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
b	d	a	d	a	b	d	b	a	a

Electromagnetic Waves

PHYSICS

1. The electric field strength in an electromagnetic wave is 10^4 V/m. The magnitude of magnetic field strength will be:
(a) $10^4\ T$ (b) $3 \times 10^{12}\ T$ (c) $3.3 \times 10^{-4}\ T$ (d) $3.3 \times 10^{-5}\ T$

2. A cube of edge a has its edges parallel to x, y and $\mathcal{Z} - axis$ of rectangular co – ordinate system. A uniform electric field E is parallel to y – axis and a uniform magnetic field is parallel to x – axis. The rate at which energy flows through each face of the cube is :



(a) zero in all faces
(b) $\frac{a^2EB}{2\mu_0}$ parallel to XY – plane face and zero in other
(c) $\frac{a^2EB}{\mu_0}$ parallel to XY – plane face and zero in others
(d) $\frac{a^2EB}{2\mu_0}$ in all faces

3. In an electromagnetic wave, the electric and magnetic fields are 100 V/m and 0.265 A/m. The maximum energy flow is:
(a) 26.5 W/m^2 (b) 36.5 W/m^2 (c) 46.7 W/m^2 (d) 765 W/m^2

4. Max well's modified from of Ampere's Circuital law is:
(a) $\oint \overrightarrow{B} \cdot \overrightarrow{dS} = 0$ (b) $\oint \overrightarrow{B} \cdot \overrightarrow{dl} = \mu_0 I$
(c) $\oint \overrightarrow{B} \cdot \overrightarrow{dl} = \mu_0 I + \frac{1}{\varepsilon_0}\frac{dq}{dt}$ (d) $\oint \overrightarrow{B} \cdot \overrightarrow{dl} = \mu_0 I + \mu_0\, \varepsilon_0 \frac{d\phi_E}{dt}$

5. An electromagnetic wave of frequency v = 3.0 MHz passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4.0$ Then:
(a) Wavelength is doubled and frequency unchanged
(b) Wavelength is doubled and frequency becomes half
(c) Wavelength is halved and frequency remains unchanged
(d) Wavelength and frequency both remains unchanged

6. The charge on a parallel plate capacitor is varying as q = q_0 sin 2pnt. The plates are very large and close together. Neglecting the edge effects, the displacement current through the capacitor is:
(a) $\frac{q}{\varepsilon_0 A}$ (b) $\frac{q_0}{\varepsilon_0} sin\, 2\, pnt$ (c) 2 pnq_0 cos 2 pnt (d) $\frac{2\pi n q_0}{\varepsilon_0}$ cos 2 pnt

7. Instantaneous displacement current of 1.0A in the space between the parallel plate of $1\mu F$ capacitor can be established by changing potential difference of:
(a) $10^{-6}\ V/s$ (b) $10^{6}\ V/s$ (c) $10^{-8}\ V/s$ (d) $10^{8}\ V/s$

8. An electromagnetic wave going through vacuum is described by E = E_0 sin $(kx - \omega t)$;B = B_0 sin (kx $- \omega t$).Which of the following equations is true?
(a) $E_0 k = B_0 \omega$ (b) $E_0 \omega = B_0 k$ (c) $E_0 E_0 = \omega k$ (d) None of these

9. A large parallel plate capacitor, whose plates have an area of 1 m^2 and are separated from each other by 1 mm, is being charged at a rate of 25 V/s. If the dielectric between the plates has the dielectric constant 10, then the displacement current at this instant is:
(a) 25 μA (b) 11 μA (c) 2.2 μA (d) 1.1 μA

10. The rms value of the electric field of the light coming from the sun is 720 N/C. The average total energy density of the electromagnetic wave is:
(a) 4.58$\times 10^{-6}\ J/m^3$ (b) 6.37$\times 10^{-9}\ J/m^3$
(c) 81.35$\times 10^{-12}\ J/m^3$ (d) 3.3$\times 10^{-3}\ J/m^3$

ANSWER KEYS

1. D	2. C	3. A	4. D	5. C	6. C	7. B	8. A	9. C	10. A

Electronic Devices

PHYSICS

1. The avalanche breakdown in P-N junction is due to
   (a) Shift of Fermi level
   (b) Cumulative effect of conduction band electron
   (c) Widening of forbidden gap
   (d) High impurity concentration

2. In the following figures, the diodes are either forward biased or reverse biased, choose the correct statement

   (a) both (P) & (Q) are forward biased
   (b) both (P) & (Q) are reverse biased
   (c) (P) is forward biased and (Q) is reverse biased
   (d) (Q) is forward biased and (P) is reverse biased

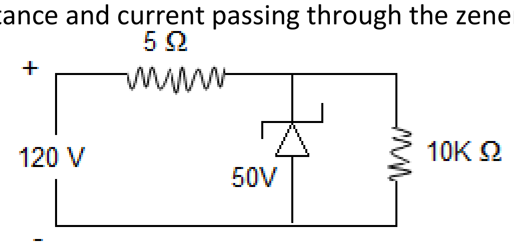
3. A zener diode when used as a voltage regulator is connected
   (1) in forward bias (2) in reverse bias (3) in parallel to the load (4) in series to the load
   (a) (1) & (2) are correct
   (b) (2) & (3) are correct
   (c) (1) only is correct
   (d) in series to the load

4. A strip of copper and another of germanium are cooled from room temperature to 80K. The resistance of
   (a) Each of these decreases
   (b) Copper strip decreases and that of germanium decreases
   (c) Copper strip decreases and that of germanium increases
   (d) Each of these increases

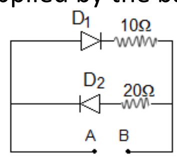
5. In a p-n junction diode made with 'Ge' the thickness of the depletion layer is $2X10^{-6}$m and barrier potential is 0.3V. strength of the electric field at the junction is
   (a) 1.5X 10^5 V/m from n to P side
   (b) 2X 10^5 V/m from n to P side
   (c) 1.5X 10^5 V/m from P to n side
   (d) 2X 10^5 V/m from P to n side

6. When a P-n junction is reverse biased, the current becomes almost constant at 25μA. When it is forward biased at 200 mV, a current of 75μA is obtained. The magnitude of diffusion current when the diode is forward biased at 200 mV is
   (a) 25μA (b) 50μA (c) 75μA (d) 100μA

7. The Voltage drop across 5Ω resistance and current passing through the zener diode in the given circuit are
   (a) 70V ; 14 amp
   (b) 70V ; 10amp
   (c) 50V ; 14 amp
   (d) 50V ; 10 amp



8. Two ideal junction diodes D_1, D_2 are connected as shown in the figure. A 3V battery is connected between A and B. The current supplied by the battery if its positive terminal is connected to 'B' is

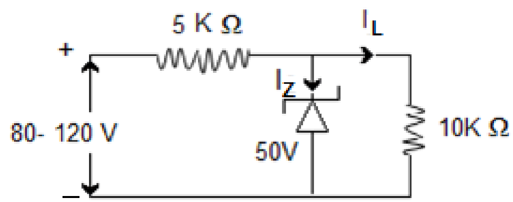


(a) 0.15 A
(b) 0.3 A
(c) 3 A
(D) 1 A

9. In a full wave rectifier circuit is operating from 50Hz mains, the fundamental frequency in the ripple will be

(a) 25 Hz (b) 50 Hz (c) 70.7 Hz (d) 100 Hz

10. From the circuit shown below, the maximum and minimum values of zener diode current are



(a) 6 mA, 5 mA (b) 14 mA, 5 mA (c) 9 mA, 1 mA (d) 3 mA, 2 mA

ANSWERS

1	2	3	4	5	6	7	8	9	10
b	c	b	c	a	d	a	a	d	c

1. The current gain 'α' of a transistor in common base mode is 0.995. Its current gain (β) in the common emitter mode is
   (a) 169 (b) 179 (c) 189 (d) 199

2. In a common emitter transistor amplifier, the audio signal voltage across the collector resistance of 2KΩ is 2V. If the base resistance is 1KΩ and the current amplification of the transistor is 100. The input voltage signal is of
   (a) 5mV (b) 8 mV (c) 10 mV (d) 12 mV

3. In common-base amplifier, the phase difference between the input signal voltage and output voltage is
   (a) $\frac{\pi}{4}$ (b) π (c) Zero (d) $\frac{\pi}{2}$

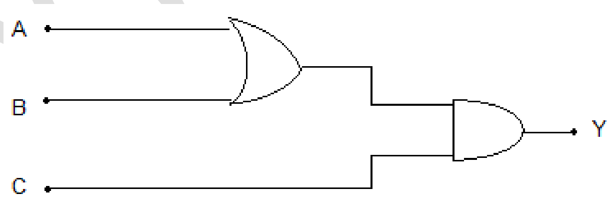
4. Match the following for CE transistor amplifier

List – 1	List – 2
Current gain	5. $\frac{\Delta I_c}{\Delta I_b}$
Voltage gain	6. $\frac{\Delta I_c}{\Delta I_b} \frac{R_L}{R_i}$
Power gain	7. $\left(\frac{\Delta I_c}{\Delta I_b}\right)^2 \frac{R_L}{R_i}$
Resistance gain	8. $\frac{R_L}{R_i}$

   (a) 1 – 5, 2 – 6, 3 – 7, 4 – 8 (b) 1 – 6, 2 – 8, 3 – 5, 4 – 7
   (c) 1 – 8, 2 – 6, 3 – 7, 4 – 5 (d) 1 – 7, 2 – 5, 3 – 6, 4 – 8

5. Transistor connected in common-emitter mode configuration is used as an amplifier. If R_L= 5KΩ and input resistance R_i = 2KΩ and current gain is 50. It's power gain is
   (a) 1250 (b) 2500 (c) 6250 (d) 12,500

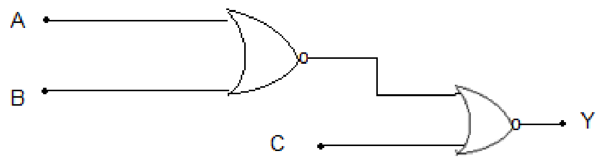
6. To get an output Y = 1 from circuit of figure below, the input must be



	A	B	C
(a)	0	1	0
(b)	1	0	0
(c)	1	0	1
(d)	1	1	0

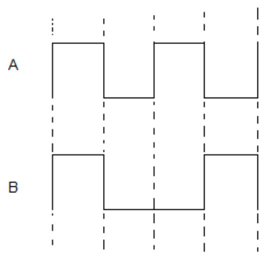
7. The input of A and B for the Boolean expression $(\overline{A} + \overline{B}).(\overline{A.B}) = 1$ is
(a) 0,0 (b) 0,1 (c) 1,0 (d) 1,1

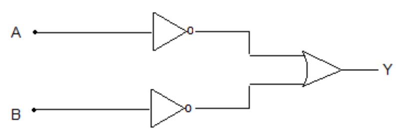
8. The Boolean expression for the output Y of the logic operation shown, is



(a) $(\overline{A+B})+c$ (b) (A+B) + $\bar{c}$ (c) $\overline{(A+B)+c}$ (d) $(\overline{A+B+C})$

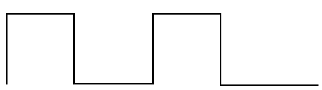
9. In a given circuit as shown the two inputs wave form A and B applied simultaneously





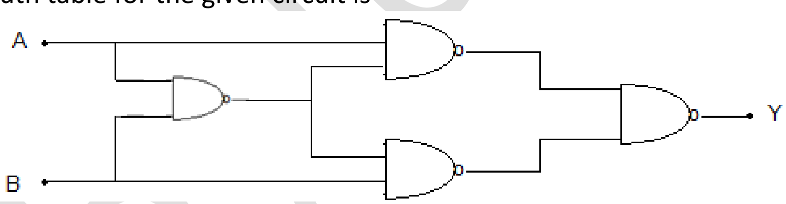
(a)


(b)


(c)


(d)


10. Truth table for the given circuit is



(a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(b)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

(c)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(d)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

ANSWERS

1	2	3	4	5	6	7	8	9	10
d	c	c	a	c	c	a	c	a	a

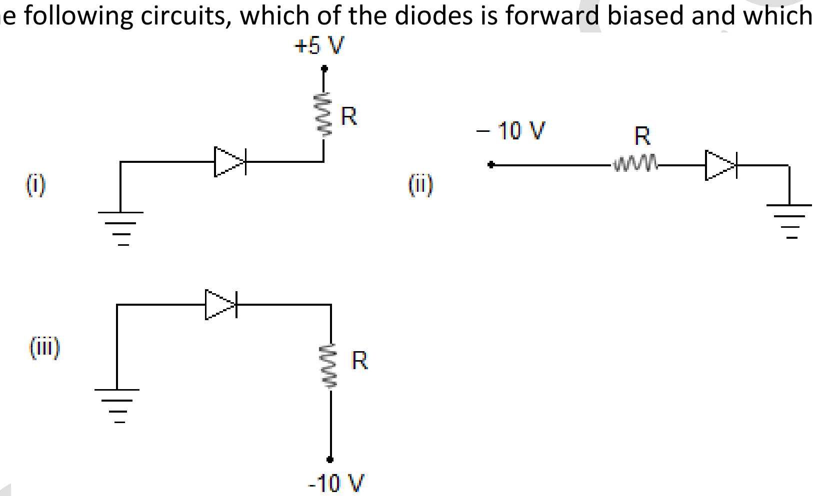
1. In an n- type silicon, which of the following statements is true?
   (a) Electrons are majority carriers and trivalent atoms are the dopants.
   (b) Electrons are minority carriers and pentavalent atoms are the dopants.
   (c) Holes are minority carriers and pentavalent atoms are the dopants
   (d) Holes are majority carriers and trivalent atoms are the dopants

2. In case of intrinsic semi conductors,
   (a) $i_e = i_h$ (b) $i_e \gg i_h$ (c) $i_h \gg i_e$ (d) data insufficient

3. When a forward bias is applied to a P-N junction, it
   (a) raises the potential barrier (b) reduces the majority carrier current to zero
   (c) lowers the potential barrier (d) none of the above

4. A P-N photo diode is fabricated from a semi conductor with band gap of 2.8 eV. It can't detect a wave length of
   (a) 1000 nm (b) 800 nm (c) 400 nm (d) Both (a) & (b)

5. In the following circuits, which of the diodes is forward biased and which is reverse biased



   (a) (ii) & (iii) are reverse biased (b) (i) & (iii) are reverse biased
   (c) (ii) & (iii) are forward biased (d) (i) & (ii) are reverse biased

6. A semi conductor has the electron concentration 0.45 X $10^{20}\ m^{-3}$ and hole concentration 5X $10^{20} m^{-3}$. If μ_e = 0.135 $m^2V^{-1}s^{-1}$, μ_h = 0.048 $m^2V^{-1}s^{-1}$ and e = 1.6 X 10^{-19}C then its conductivity is
   (a) 4.812 Sm^{-1} (b) 5.026 Sm^{-1} (c) 6.314 Sm^{-1} (d) 7.084 Sm^{-1}

7. In a forward – biased silicon diode, current occurs at close to 0.7V and increases rapidly with very small further potential difference increase. If there is a 200Ω resistor in series with the diode with a 10-V battery across the series combination, then the current flow will be
   (a) 28.4 mA (b) 34.6 mA (c) 46.5 mA (d) 51.2 mA

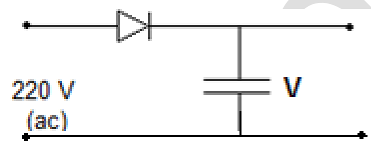
8. The following table provides the set of values of V and I obtained for a given diode

Forward Biasing		Reveise Biasing	
V	I	V	I
2V	60 mA	0 V	0 μA
2.4V	80 mA	-2 V	-0.25 μA

Assuming the characteristics to be nearly linear, over this range, the forward & reverse bias resistance of the given diode are

(a) 5Ω,4X10^6Ω (b) 8Ω, 5X10^6Ω (c) 10Ω, 6X10^6Ω (d) 20Ω, 8X10^6Ω

9. A diode is connected to 220 V (rms) a c in series with a capacitor as sho0wn in figure. The voltage V across the capacitor is



(a) 311.1 v
(b) 354.2 v
(c) 423.4 v
(d) 516.2 v

10. A full wave rectifier makes use of two identical junction diodes having negligible forward resistance. When a sinusoidal voltage supply of peak value 100V is fed to the rectifier, the rms value of voltage across R_L is

(a) 35.2 V (b) 43.5 V (c) 61.3 V (d) 70.7 V

Answer Key

1	2	3	4	5	6	7	8	9	10
c	a	c	d	d	a	c	d	a	d

1. In n-p-n transistor the arrow head on emitter represents that the conventional current flows from
   (a) base to emitter (b) emitter to base (c) emitter to collector (d) base to collector

2. The correct relation between current gains '$\propto$' and 'β' is
   (a) $\beta = \frac{\propto}{1-\propto}$ (b)) $\beta = \frac{\propto}{1+\propto}$ (c) $\beta = \propto(1 - \propto)$ (d) $\beta = \frac{1-\propto}{\propto}$

3. For a transistor I_c = 25mA and I_B = 1 mA. The value of current gain $\propto$ is
   (a) $\frac{26}{25}$ (b)) $\frac{25}{26}$ (c)) $\frac{13}{15}$ (d)) $\frac{15}{13}$

4. A common emitter transistor amplifies a weak current signal because collector current is
   (a) β times I_b (b) β times I_c (c) $\propto$ times I_b (d) $\propto$ times I_c

5. When n-p-n transistor is used as an amplifier
   (a) electrons moves from base to collector
   (b) holes moves from emitter to base
   (c) holes moves from collector to base
   (d) holes moves from base to emitter

6. The Boolean expression Y = $\overline{A + B}$ represents the output of
   (a) NOR gate (b) AND gate (c) NAND gate (d) OR gate

7. In the Boolean algebra $\left(\overline{\bar{A} \cdot \bar{B}}\right) \cdot A$ equals to
   (a) $(A + B)$ (b) A (c) $(\overline{A \cdot B})$ (d) A + B

8. The truth table of XOR gate is

(a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

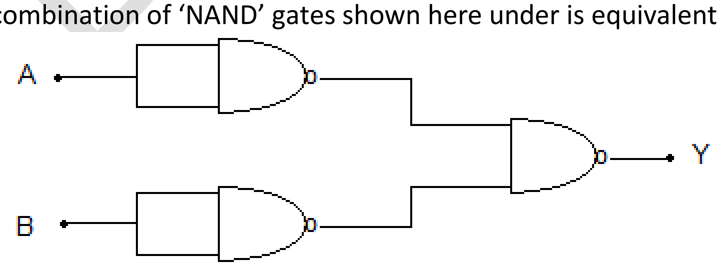
(c)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	0

(d)

A	B	Y
0	0	0
1	1	0
0	1	1
1	0	1

9. The combination of 'NAND' gates shown here under is equivalent to



   (a) AND gate (b) OR gate (c) XOR gate (d) NAND gate

10. According to Demorgan's theorem
(a) $\overline{A+B+C}$ = $\bar{A}$+$\bar{B}$+$\bar{C}$ (b) $\overline{ABC}$ = $A\overline{BC}$ (C) $\overline{ABC} = \bar{A}$+$\bar{B}$+$\bar{C}$ (D)$\overline{A+B+C}$ = ABC

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
a	a	b	a	a	a	b	d	b	c

Electrostatics

PHYSICS

1. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be:
(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$ (c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\sqrt{\frac{4\pi\varepsilon_0 Fd}{e}}$

2. The force between two identical point charges in F. What will be the force if each charge is increased by 2% and the distance between them is decreased by 3%?
(a) 1.1 F (b) 1.2 F (c) 1.6 F (d) 1.8 F

3. Ten positively charged particles are kept fixed on the $X-$axis at points $x = 10 \text{ cm}, \ 20 \text{ cm}, \ 30 \text{ cm}, ...100 \text{ cm}$. The first particle has a charge $1.0\times10^{-8}C$, the second $8\times10^{-8}C$, the third $27\times10^{-8}C$ and so on. The tenth particle has a charge 1000×10^{-8} C. Find the magnitude of the Coulomb force acting on a 1C charge placed at the origin.
(a) 5×10^5 N (b) 6×10^5 N (c) 4.95×10^5 N (d) 9×10^5 N

4. Two identical conducting spheres A and B are separated by a distance greater than their diameters. The spheres carry equal charges and the electrostatic force between them is F. A third identical uncharged sphere C is first brought in contact with A, then with B and finally removed. As a result, the electrostatic force between A and B becomes:
(a) $\frac{F}{2}$ (b) $\frac{3F}{8}$ (c) $\frac{F}{16}$ (d) $\frac{F}{4}$

5. Three charges each of magnitude $100\mu C$ are located in vacuum at the corners A, B and C of an equilateral triangle of side 3m. If charges placed at A and C are positive and the one placed at B is negative, then the magnitude and direction of the force F experienced by the charge placed at C is :
(a)10 N parallel to AB (b) 20N parallel to AB (c) 20N parallel to BC (d) 20N parallel to AC

6. Two identical pith balls, each carrying a charge q, are suspended from a common point by two strings of equal length l. Find the mass of each ball if the angle between the strings is 2θ in equilibrium.
(a) $\frac{q^2 \cot\theta}{16\pi \epsilon_0 gl^2 \sin^2\theta}$ (b) $\frac{q^2 \sin\theta}{16\pi \epsilon_0 gl^2 \cot^2\theta}$ (c) $\frac{q^2 \cot\theta}{8\pi \epsilon_0 gl^2 \sin^2\theta}$ (d) none

7. Two identical charged spheres are suspended by strings of equal length and strings makes some angle with each other in air. When suspended in a liquid of density 400 kg/m^3, the angle remains same. If the density of the material of the sphere is 1600 kg/m^3, the dielectric constant of the material of the liquid is
(a) 1.33 (b) 2 (c) 3.12 (d) 5

8. A particle A having a charge of 2.0×10^{-6} C is held fixed on a horizontal table. A second charged particle of mass $80\,\text{g}$ stays in equilibrium on the table at a distance of $10\,\text{cm}$ from the first charge. The coefficient of friction between the table and this second particle is $\mu = 0.2$. Find the range within which the charge of this second particle may lie.

(a) between $\pm 8.71\times10^{-8}C$ (b) between $\pm 8.71\times10^{-6}C$

(c) between $\pm 8.71\times10^{-3}C$ (d) none

9. A thin wire ring of radius r has an electric charge q. The increment in the tension in the wire if a point charge q_0 is placed centre of the ring is:

(a) zero (b) $\frac{qq_0}{2\pi^2\varepsilon_0 r^2}$ (c) $\frac{qq_0}{4\pi^2\varepsilon_0 r^2}$ (d) $\frac{qq_0}{8\pi^2\varepsilon_0 r^2}$

10. Four equal positive charges each of value Q are arranged at the four corners of a square of side a. A unit positive charge mass m is placed at P, at a height h above the centre of the square. What should be the value of Q in order that this unit charge is in equilibrium?

(a) $\frac{mg\pi\varepsilon_0}{h}\left(h^2+\frac{a^2}{2}\right)^{3/2}$ (b) $\frac{mg\pi\varepsilon_0}{h}\left(h^2+\frac{a^2}{\sqrt{2}}\right)^{3/2}$

(c) $\frac{4mg\pi\varepsilon_0}{h}\left(h^2+\frac{a^2}{2}\right)^{3/2}$ (d) $\frac{4mg\pi\varepsilon_0}{h}\left(h^2+\frac{a^2}{\sqrt{2}}\right)^{3/2}$

ANSWER KEY

1. c	2. a	3. c	4. b	5. a	6. a	7. a	8. a	9. d	10. a

1. A particle of mass m and charge q is thrown at a speed u against a uniform electric field E. The distance it will travel before coming to momentary rest is:

(a) $\frac{mu^2}{2qE}$ (b) $\frac{2mu^2}{qE}$ (c) $\frac{mu^2}{qE}$ (d) $\frac{mu^2}{\sqrt{2}qE}$

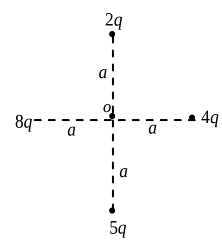
2. A charged particle of mass $m = 1\,\text{kg}$ and charge $q = 2\mu C$ is thrown from a horizontal ground at an angle $\theta = 45^\circ$ with speed $20\,\text{m/s}$. In space a horizontal electric field $E = 2\times10^7\ \text{V/m}$ exist. Find the range on horizontal ground of the projectile thrown.

(a) 400 m (b) 200 m (c) 300 m (d) 500 m

3. A positive point charge $50\mu C$ is located in the plane xy at the point with radius vector $r_0 = 2\hat{i} + 3\hat{j}$, where $\hat{i}$ & $\hat{j}$ are the unit vectors of the x & y axes. Find the Electric field vector (in kNC^{-1}) at the point with radius vector $r = 8\hat{i} - 5\hat{j}$. Here r_0 & r are expressed in metres.

(a) $E = 2.7\hat{i} - 3.6\hat{j}$ (b) $E = 2.7\hat{i}$ (c) $E = -3.6\hat{j}$ (c) $E = 3.6\hat{i} - 2.7\hat{j}$

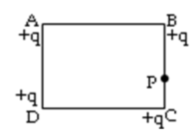
4. A set of four charges $2q$, $4q$, $5q$ and $8q$ are arranged as shown in the figure. The intensity of electric field at point O is



(a) $5\frac{kq}{a^2}$ (b) $19\frac{kq}{a^2}$

(c) $7\frac{kq}{a^2}$ (d) $16\frac{kq}{a^2}$

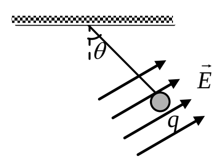
5. Four charges $+q$ each are located at the vertices of a square ABCD of side a as shown in figure. Find the electric field E at the midpoint of side BC.



(a) $\frac{1}{5\sqrt{5}\pi\in_0}\frac{q}{a^2}$ (b) $\frac{4}{5\sqrt{5}\pi\in_0}\frac{q}{a^2}$

(c) 0 (d) None

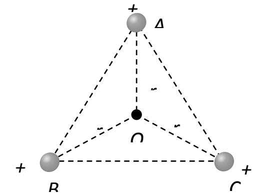
6. A charged cork ball of mass $1g$ is suspended on a light string in the presence of a uniform electric field as shown. When $\vec{E} = \left(3\hat{i} + 5\hat{j}\right)\times10^5 NC^{-1}$, the ball is in equilibrium at $\theta = 37^\circ$. T is the tension in the string and q is the charge on the ball (Take $\sin 37^\circ = 0.60$ and $g = 10ms^{-2}$)



(a) $q = 11nC$ (b) $q = 12nC$

(c) $T = 5.55\times10^{-3}N$ (d) $T = 4.55\times10^{-3}N$

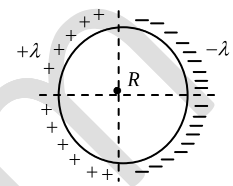
7. ABC is an equilateral triangle. Charges $+q$ are placed at each corner. The electric intensity at O will be



(a) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

(c) Zero (d) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{r^2}$

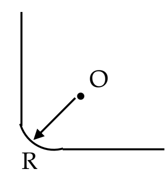
8. The intensity of electric field at the centre of a ring charged uniformly with linear charge density λ as shown in the figure is



(a) zero (b) $\frac{4k\lambda}{.R}$

(c) $\sqrt{2}\frac{k\lambda}{R}$ (d) $\frac{k\lambda}{.R}$

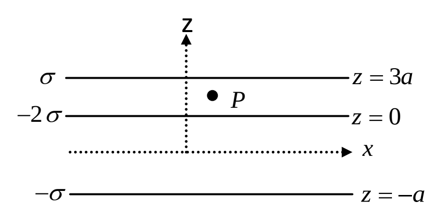
9. A thread carrying a uniform charge λ per unit length has the configuration shown in figures. Assuming a curvature radius R to be considerably less than the length of the thread, find the magnitude of the electric field strength at the point O.



(a) $\frac{\lambda\sqrt{2}}{4\pi\varepsilon_0 R}$ (b) $\frac{2\lambda}{4\pi\varepsilon_0 R}$

(c) $\frac{\lambda\sqrt{2}}{8\pi\varepsilon_0 R}$ (d) zero

10. Three infinitely long charged sheets are placed as shown in figure. The electric field at point P is:



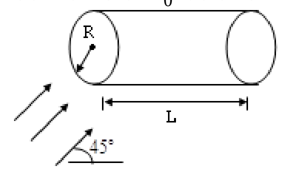
(a) $\frac{2\sigma}{\varepsilon_0}\hat{k}$ (b) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$

(c) $\frac{4\sigma}{\varepsilon_0}\hat{k}$ (d) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$

ANSWER KEY

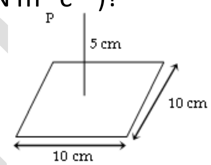
1. a	2. b	3. a	4. a	5. b	6. a, c	7. c	8. b	9. a	10. d

1. A cylinder of radius R and length L in placed in a uniform electric field E_0 as shown. What is the flux through the cylinder.



(a) $\pi R^2 E_0$ (b) $2\pi RLE_0$
(c) zero (d) $2\pi R^2 E_0$

2. A point charge $+10\mu C$ is at a distance $5\,\text{cm}$ directly above the centre of a square of side 10cm as shown in the figure. What is the magnitude of the electric flux through the square (in $\text{N m}^2\ \text{c}^{-1}$)?



(a) 1.88×10^5 (b) zero
(c) 2.46×10^5 (c) 3.88×10^5

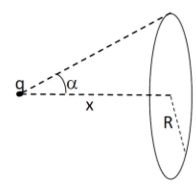
3. Electric flux through a surface of area 100 m^2 lying in the xy plane is (in V-m) if $\vec{E} = \hat{i} + \sqrt{2}\hat{j} + \sqrt{3}\hat{k}\ \text{Vm}^{-1}$ is

(a) 100 (b) 141.4 (c) 173.2 (d) 200

4. A point charge q lies at one corner of an imaginary cube. Find the flux penetrating each of the three faces that join at the corner where the charge is located and the flux penetrating each of the other three faces.

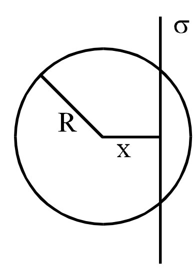
(a)zero, $\frac{q}{\varepsilon_0}$ (b) zero, $\frac{q}{8\varepsilon_0}$ (c) zero, $\frac{q}{24\varepsilon_0}$ (d) $\frac{q}{6\varepsilon_0}, \frac{q}{6\varepsilon_0}$

5. A point charge q is located at a distance x from the center of an imaginary circle of radius R as shown. Find the flux due to q through the circle.



(a)zero (b) $\frac{q}{\varepsilon_0}\cos\alpha$ (c) $\frac{q}{\varepsilon_0}(1-\cos\alpha)$ (d) $\frac{q}{2\varepsilon_0}(1-\cos\alpha)$

6. An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its centre, as shown in the figure. The electric flux through the Gaussian surface is



(a) $\frac{\pi R^2 \sigma}{\varepsilon_0}$ (b) $\frac{2\pi(R^2 - x^2)\ \sigma}{\varepsilon_0}$

(c) $\frac{\pi(R-x)^2\ \sigma}{\varepsilon_0}$ (d) $\frac{\pi(R^2 - x^2)\ \sigma}{\varepsilon_0}$

7. In a region of space, the electric field is in the x direction and is given as $\vec{E} = E_0 x \hat{i}$. Consider an imaginary cubical volume of edge a, with its edges parallel to the axes of coordinates. The charge inside this volume is:

(a) zero (b) $\varepsilon_0 E_0 a^3$ (c) $2\varepsilon_0 E_0 a^3$ (d) $3\varepsilon_0 E_0 a^3$

8. Consider two infinitely long concentric cylindrical shells. The inner shell has radius R_1 and carries a uniform surface charge density σ_1 while the outer shell has radius R_2 and carries a uniform surface charge density σ_2 What should be the ratio $\frac{\sigma_2}{\sigma_1}$ for the electric field to be zero at $r > R_2$?

(a) $\frac{\sigma_1}{\sigma_2} = -\frac{R_2}{R_1}$ (b) $\frac{\sigma_1}{\sigma_2} = -\frac{R_1}{R_2}$ (c) $\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$ (d) $\frac{\sigma_1}{\sigma_2} = \frac{R_1}{R_2}$

9. A ball of radius R carries a positive charge whose volume density depends only on a separation r from the ball's centre as $\rho = \rho_0\left(1 - \frac{r}{R}\right)$, where ρ_0 is a constant. Assuming the permittivities of the ball and the environment to be equal to unity, find the maximum intensity E_{max} .

(a) $\frac{\rho_0 R}{\varepsilon_0}$ (b) $\frac{\rho_0 R}{2\varepsilon_0}$ (c) $\frac{\rho_0 R}{9\varepsilon_0}$ (d) $\frac{\rho_0 R}{3\varepsilon_0}$

10. The electric field strength depends only on the x and y coordinates according to the law $\vec{E} = a\left(\frac{x\hat{i} + y\hat{j}}{x^2 + y^2}\right)$, where a is a constant, i and j are the unit vectors along the x and y axes. Find the flux of the field through a sphere of radius R with its centre at the origin of coordinates.

(a) $4\pi r^2$ (b) $4\pi ra$ (c) $4\pi a^2$ (d) zero

ANSWER KEY

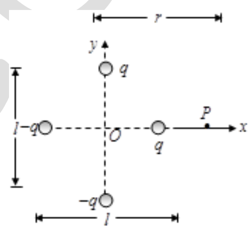
1. c	2. a	3. c	4. c	5. d	6. d	7. b	8. a	9. c	10. b

1. Two particles A and B, having opposite charges $2.0\times10^{-6}\,C$ and $-2.0\times10^{-6}\,C$, are placed at a separation of $1\ \mu m$. Calculate the electric field at a point on the axis of the dipole 1m away from the centre (in NC^{-1}).
   (a) 36 (b) 3.6 (c) 0.36 (d) 0.036

2. Two charges $\pm2\times10^{-6}C$ separated by $1\mu m$ comprise a dipole. The dipole is placed in a uniform electric field of strength $20kVm^{-1}$ such that it makes an angle of 60^0 with the dipole moment. Find the work done (in nJ) in rotating the dipole such that the angle becomes 120^0.
   (a)40 (b) 80 (d) zero (d) 60

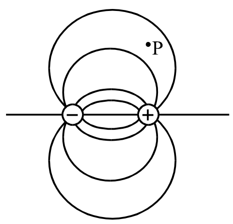
3. A small electric dipole of dipole moment p is placed at origin with its dipole moment directed along positive $x-$axis. Find the locus of points at which electric field is along the $y-$axis.
   (a) $y=\pm x$ (b) $y=\pm\sqrt{2}x$ (d) $y=\pm2x$ (d) $y=\pm3x$

4. Charges are arranged as shown in figure. A point P is located at distance r from the centre of the configuration. Assuming $r>>l$, the field at point P is

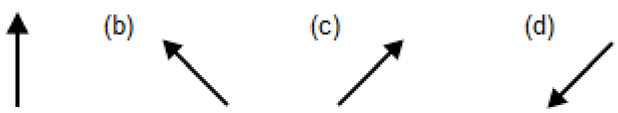


   (a) is of magnitude $\dfrac{2\sqrt{5}ql}{4\pi\varepsilon_0 r^3}$
   (b) is of magnitude $\dfrac{\sqrt{5}ql}{4\pi\varepsilon_0 r^3}$
   (c) makes an angle $\tan^{-1}(2)$ with x-axis
   (d) makes an angle $\tan^{-1}\left(\dfrac{1}{2}\right)$ with x-axis

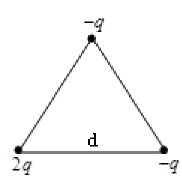
5. Figure shows the electric field lines around an electric dipole. Which of the arrows best represents the electric field at point P?



(a) (b) (c) (d)



6. Three charges are arranged on the vertices of an equilateral triangle as shown in figure. Find the dipole moment of the combination.



   (a) qd (b) 2qd (c) 3qd (d) $\sqrt{3}$qd

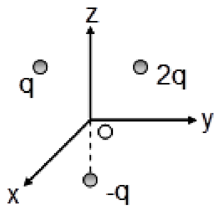
7. Three point charges $2q, q$ and $-q$ are located respectively at $(0,a,a,),(0,-a,a)$ and $(0,0,-a)$ as shown. The dipole moment of this distribution is

(a) $2qa$ in the yoz plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with $z-$axis

(b) $\sqrt{17}qa$ in the yoz plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with $z-$axis

(c) $\sqrt{5}qa$ in the xoy plane at $\tan^{-1}(4)$ with y – axis

(d) $4qa$ in the xoy plane at $\tan^{-1}(4)$ with y – axis



8. The dipole moment of a system of charge +q distributed uniformly on an arc of radius R subtending an angle $\frac{\pi}{2}$ at its centre where another charge -q is placed is :

(a) $\frac{2\sqrt{2}qR}{\pi}$ (b) $\frac{\sqrt{2}qR}{\pi}$ (c) $\frac{qR}{\pi}$ (d) $\frac{2qR}{\pi}$

9. A dipole having dipole moment $'P'$ is kept very close to a charged ring carrying charge Q and radius R. If the dipole is at a distance $x(<< R)$ along the axis from the centre of the ring, then the force experienced by the dipole is

(a) $\frac{KQP}{R^3}$ (b) $\frac{2KQP}{R^3}$ (c) $\frac{KQP}{\left(R^2+x^2\right)^{3/2}}$ (d) $\frac{KQP}{\left(R^2-x^2\right)^{3/2}}$

10. A dipole consists of two particles one with charge +10mC and mass 1kg and the other with charge –10mC and mass 2kg separated by a distance of 3m. For small oscillations about its equilibrium position, the angular frequency, when placed in a uniform electric field of 20kV/m is

(a) 0.1rad/s (b) 1.1 rad/s (c) 10 rad/s (d) 2.5rad/s

ANSWER KEY

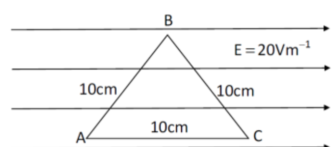
1. d	2. a	3. b	4. b, c	5. b	6. d	7. b	8. a	9. a	10. c

1. An infinite number of charges each equal to q and alternatively positive and negative are placed along the x axis at $x=1, x=2, x=4, x=8$ and so on. (a) Find the potential at the point $x=0$ due to this set of charges.
   (a) $\frac{3Q}{4\pi\varepsilon_0}$ (b) $\frac{Q}{2\pi\varepsilon_0}$ (c) $\frac{Q}{6\pi\varepsilon_0}$ (d) zero

2. In a regular polygon of n sides, each corner is at a distance r from the centre. Identical charges are placed at (n – 1) corners. At the centre, the intensity is E and the potential is V. The ratio V/E has magnitude.
   (a) r n (b) r (n – 1) (c) (n – 1)/r (d) r(n – 1)/n

3. Two electric charges $q_1=-2q$ and $q_2=q$ are placed at a distance $l=6a$ apart. Find the locus of points in the plane of the charge where the electric potential is zero (Take centre of the distribution as the origin).
   (a) $(x-5a)^2+y^2=16a^2$ (b) $x^2+y^2=16a^2$ (c) $2x+3y=4a$ (c) none

4. The figure shows there points A, B and C in a uniform Electric field. The value of $V_{BC}-V_{CA}$ is ($V_{BC}=V_B-V_C$):



   (a)5V (b) 3V
   (c) -5V (d) -3V

5. The potential at a point $(x,0,0)$ is given by $V=\left(\frac{1000}{x}+\frac{1500}{x^2}+\frac{500}{x^3}\right)$. Find the field intensity at the point where $x=1m$.
   (a) $E_x=5500\hat{i}Vm^{-1}$ (b) $E_x=55\hat{i}Vm^{-1}$ (c) $E_x=550\hat{i}Vm^{-1}$ (d) $E_x=5.5\hat{i}Vm^{-1}$

6. The electric field is given by $\vec{E}=3\hat{i}+4\hat{j}+5\hat{k}$. Find the p.d between the points (1,1,2) and (2,3,4).
   (a)21V (b) -21V (c) 32 V (d) -32V

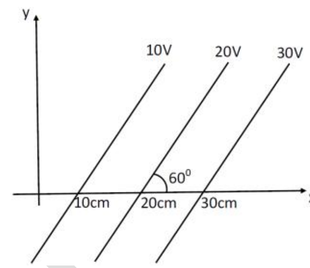
7. An electric field is given by $\vec{E}=(y\hat{i}+x\hat{j})N/C$. The work done in moving a 1C charge from $\vec{r_A}=(2\hat{i}+2\hat{j})m$ to $\vec{r_B}=(4\hat{i}+2\hat{j})m$ is:
   (a) 4 J (b) –4 J (c) 8 J (d) Zero

8. Determine the potential $\varphi(x,y,z)$ of an electric field $E=ay\hat{i}+(ax+bz)\hat{j}+by\hat{k}$ where a and b are constants $\hat{i},\hat{j},\hat{k}$ are the unit vectors of the axes x, y, z.
   (a) $\varphi=-y(ax+bz)+$ const. (b) $\varphi=y(ax+bz)+$ const.
   (c) $\varphi=-y^2(ax+bz)+$ const. (d) $\varphi=-y(ax^2+bz^2)+$ const.

9. The equation of an equipotential line in an electric field is y = 2x, then the electric field strength vector at (1, 2) may be

(a) $4\hat{i}+3\hat{j}$ (b) $4\hat{i}+8\hat{j}$ (c) $8\hat{i}+4\hat{j}$ (d) $-8\hat{i}+4\hat{j}$

10. A group of equipotential surfaces in shape of parallel planes are as shown in the figure. The electric field in the region is given by (in NC^{-1}):



(a) $100\hat{i}+\frac{100}{\sqrt{3}}\hat{j}$ (b) $-100\hat{i}+\frac{200}{\sqrt{3}}\hat{j}$

(c) $-100\hat{i}+\frac{100}{\sqrt{3}}\hat{j}$ (d) $100\hat{i}-\frac{100}{\sqrt{3}}\hat{j}$

ANSWER KEY

1. c	2. b	3. a	4. b	5. a	6. b	7. b	8. a	9. d	10. c

1. Three concentric shells A, B and C have radii $R, 2R$ and $3R$. A is given a charge q and C is given a charge $2q$ and B is earthed. The charges on the inner and outer surfaces of A, B and C are

(a)

	A	B	C
Inner	0	$-q$	$\frac{2q}{3}$
Outer	q	$-\frac{2q}{3}$	$\frac{4q}{3}$

(b)

	A	B	C
Inner	0	$-q$	$\frac{2q}{3}$
Outer	q	$-\frac{2q}{3}$	$\frac{4q}{3}$

(c)

	A	B	C
Inner	0	$-q$	$\frac{4q}{3}$
Outer	q	$-\frac{4q}{3}$	$\frac{2q}{3}$

(d)

	A	B	C
Inner	0	$-q$	$\frac{4q}{3}$
Outer	q	$-\frac{4q}{3}$	$\frac{2q}{3}$

2. Answer the previous question if everything else remains the same and A and B are connected by means of a conducting wire.

(a)

	A	B	C
Inner	0	$+q$	$\frac{2q}{3}$
Outer	$-q$	$-\frac{2q}{3}$	$\frac{4q}{3}$

(b)

	A	B	C
Inner	0	$-\frac{6q}{11}$	$\frac{18q}{11}$
Outer	$\frac{6q}{11}$	$-\frac{18q}{11}$	$\frac{9q}{11}$

(c)

	A	B	C
Inner	0	$-q$	$\frac{q}{3}$
Outer	q	$-\frac{q}{3}$	$\frac{5q}{3}$

(d)

	A	B	C
Inner	0	$\frac{6q}{11}$	$\frac{30q}{11}$
Outer	$-\frac{6q}{11}$	$-\frac{30q}{11}$	$-\frac{8q}{11}$

3. The kinetic energy of a charged particle decreases by $10\,\text{J}$ as it moves from a point at potential $100\,\text{V}$ to a point at potential $200V$. Find the magnitude of the charge on the particle.
(a) $0.1\,\text{C}$ (b) 0.2 C (c) 1 C (d) 2 C

4. A charge of $100\mu c$ is fixed is space. A light particle of mass $4gm$ and charge $1\mu c$ is projected towards $100\mu c$ charge with a velocity of $50ms^{-1}$. The initial separation is $\left(\frac{90}{13}\right)cm$ then the distance of closest approach is
(a) $10mm$ (b) $2.5mm$ (c) $8.4mm$ (d) $50mm$

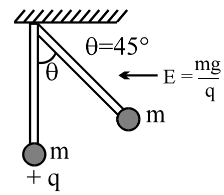
5. In a certain region of space, electric potential V is given by $V = ax^2 + ay^2 + 2az^2$ (where a is a constant of proper dimensions). A $2\mu C$ test charge moves from $(0.1\,m, 0.1\,m)$ to the origin and in the process the work done by the field is 5×10^{-5} J. What is the value of a ?

(a) $125 V/m^2$ (b) $1250 V/m^2$ (c) $12.5 V/m^2$ (d) $12500 V/m^2$

6. Two identical particles of mass m carry a charge Q each. Initially one is at rest on a smooth horizontal plane and the other is projected along the plane directly towards first particle from a large distance with speed v . The closest distance of approach be

(a) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{mv}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{4Q^2}{mv^2}$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{2Q^2}{mv^2}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{3Q^2}{mv^2}$

7. In space of horizontal Electric field $E = \frac{mg}{q}$ exists as shown in figure and a mass m attached at the end of a light rod. If mass m is released from the position shown in figure find the angular velocity of the rod when it passes through the bottom most position

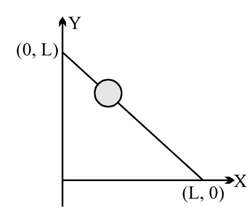


(a) $\sqrt{\frac{g}{l}}$ (b) $\sqrt{\frac{2g}{l}}$

(c) $\sqrt{\frac{3g}{l}}$ (d) $\sqrt{\frac{5g}{l}}$

8. Electric field given by $\vec{E} = x\hat{i} + y\hat{j}\ NC^{-1}$ is present in the XY plane. A small bead carrying charge +Q, which can freely slide on a smooth non conducting rod, is projected along the rod from the point (0, L) such that it can reach the other end of the rod. What minimum velocity should be given to the bead?

(Assume zero gravity)



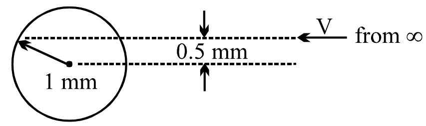
(a) $\sqrt{\frac{QL^2}{m}}$ (b) $2\sqrt{\frac{QL^2}{m}}$

(c) $4\sqrt{\frac{QL^2}{m}}$ (d) $\sqrt{\frac{QL^2}{2m}}$

9. Two identical thin rings, each of radius R meter are coaxially placed at distance R meter apart. If Q_1 and Q_2 coulomb are respectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of the other is

(a) zero (b) $\frac{\left(\sqrt{2}-1\right)q\left(Q_2-Q_1\right)}{\left(4\sqrt{2}\pi\varepsilon_0 R\right)}$ (c) $\frac{\sqrt{2}q\left(Q_1+Q_2\right)}{4\pi\varepsilon_0 R}$ (d) $\frac{\left(\sqrt{2}+1\right)q\left(Q_2-Q_1\right)}{4\sqrt{2}\pi\varepsilon_0 R}$

10. A particle of mass 1 kg & charge $\frac{1}{3}$ μ a is projected towards a non-conducting fixed spherical shell having the same charge uniformly distributed on its surface. Find the minimum initial velocity of projection required if the particle just grazes the shell.



(a) $\sqrt{\frac{2}{3}}$ m/s (b) $2\sqrt{\frac{2}{3}}$ m/s

(c) $\frac{2}{3}$ m/s (d) none of these

ANSWER KEY

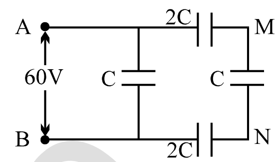
1. c	2. b	3. a	4. d	5. b	6. b	7. b	8. d	9. b	10. b

1. A capacitor of capacitance 1 mF with stands the maximum voltages 6 KV while a capacitor of capacitance 2.0 mF with stands the maximum voltage = 4KV. if the two capacitors are connected in series, then the two capacitors combined can take up a maximum voltage of

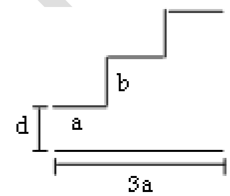
(a) 2.4 KV (b) 5 KV (c) 9 KV (d) 10 KV

2. In the circuit shown, a potential difference of 60V is applied across AB. The potential difference between the point M and N is

(a) 10 V (b) 15 V (c) 20 V (d)30 V



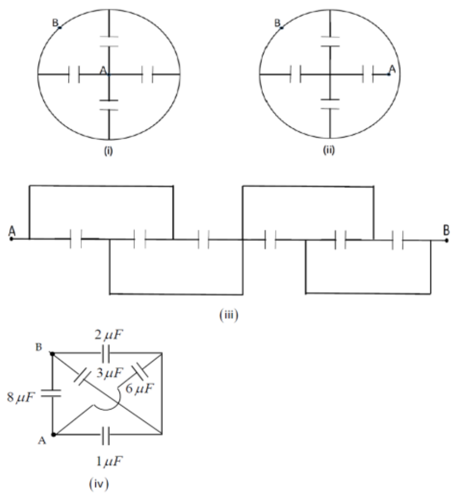
3. A capacitor is made of a flat plate of area A and a second plate having a stair-like structure as shown in figure. The width of each stair is a and the height is b. Find the capacitance of the assembly



(a) $\frac{\varepsilon_0 A\left(3d^2+6bd+2b^2\right)}{3d\left(d+b\right)\left(d+2b\right)}$ (b) $\frac{\varepsilon_0 A\left(3d^2+6bd+2b^2\right)}{d\left(d+b\right)\left(d+2b\right)}$

(c) $\frac{\varepsilon_0 A\left(3d^2+6bd+b^2\right)}{3d\left(d+b\right)\left(d+b\right)}$ (d) $\frac{\varepsilon_0 A\left(3d^2+4bd+2b^2\right)}{3d\left(d+2b\right)\left(d+2b\right)}$

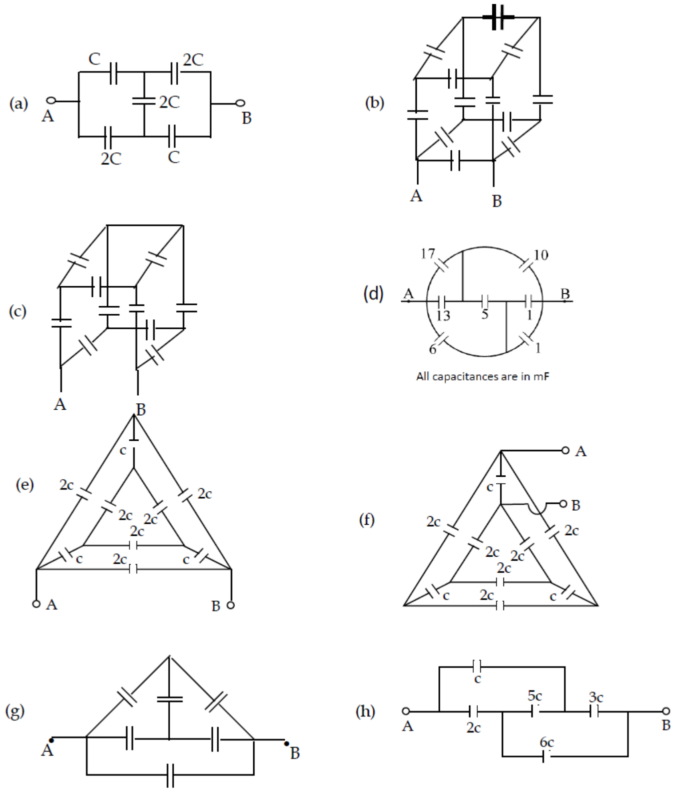
4. Unless otherwise mentioned all the capacitors have a capacitance c . Find the effective capacitance between A and B:



(a) 4c (b) $\frac{3c}{4}$

(c) $\frac{3c}{2}$ (d) $\frac{121}{12}\mu F$

5. Unless otherwise mentioned all the capacitors have a capacitance c. Find the effective capacitance between A and B



(a) $\dfrac{10c}{7}$ (b) $\dfrac{12c}{7}$

(c) $\dfrac{8c}{9}$ (d) 9mF

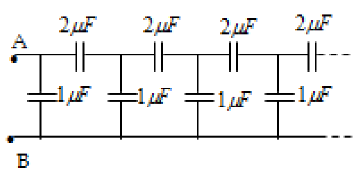
(e) $\dfrac{3c}{7}$ (f) 2c

(g) 2c (h) $\dfrac{9c}{4}$

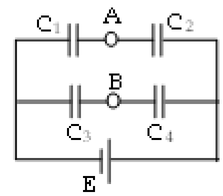
6. Find the equivalent capacitance of the infinite ladder shown in figure between the points A and B

(a) $2\mu F$ (b) $3\mu F$

(c) $0.5\mu F$ (d) $1\mu F$



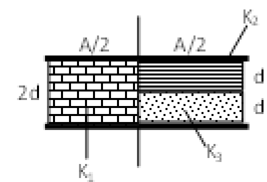
7. Determine the potential difference $\phi_A - \phi_B$ between points A and B of the circuit shown in figure.



(a) $\frac{(C_2C_3 - C_1C_4)E}{(C_1+C_2)(C_3+C_4)}$ (b) zero

(C) $\frac{(C_1C_3 - C_2C_4)E}{(C_1+C_2)(C_3+C_4)}$ (d) $\frac{(C_2C_3 - C_1C_4)E}{(C_1-C_2)(C_3-C_4)}$

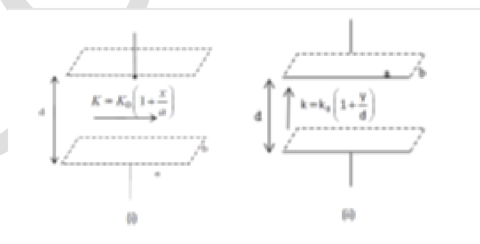
8. What is the capacitances of the capacitor, of plate area A, shown in figure?



(a) $\frac{\varepsilon_0 A}{4d}\left(k_1 + \frac{2k_2k_3}{k_2+k_3}\right)$ (b) $\frac{\varepsilon_0 A}{2d}\left(k_1 + \frac{k_2k_3}{k_2+k_3}\right)$

(c) $\frac{\varepsilon_0 A}{4d}\left(k_1 + \frac{k_2k_3}{k_2+k_3}\right)$ (d) $\frac{\varepsilon_0 A}{d}\left(k_1 + \frac{2k_2k_3}{k_2+k_3}\right)$

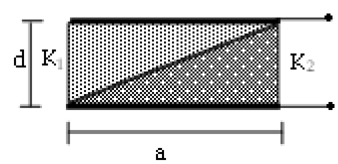
9. The dielectric constant of a material in between the plates of a capacitor varies as shown in the diagrams. Find ratio of the effective capacitance in the two cases.



(a) $\frac{\ln(2)}{2}$ (b) $\ln(2)$

(c) $\frac{2\ln(2)}{3}$ (d) $\frac{3\ln(2)}{2}$

10. A capacitor is formed by two square metal-plates of edge a, separated by a distance d. Dielectrics of dielectric constants K_1 and K_2 are filled in the gap as shown in figure. Find the capacitance.



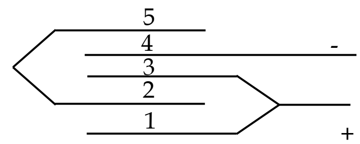
(a) $\frac{\varepsilon_0 K_1 K_2 a^2}{(K_1-K_2)d}$ (b) $\frac{2\varepsilon_0 K_1 K_2 a^2 \ln\frac{K_1}{K_2}}{(K_1+K_2)d}$

(c) $\frac{\varepsilon_0 K_1 K_2 a^2 \ln\frac{K_1}{K_2}}{(K_1-K_2)d}$ (d) $\frac{3\varepsilon_0 K_1 K_2 a^2 \ln\frac{K_1}{K_2}}{2(K_1-K_2)d}$

ANSWER KEY

1. c	2. d	3. b	4.	5.	6. a	7. a	8. a	9. d	10. c

1. Five identical conducting plates 1,2,3,4 and 5 are fixed parallel plates equidistant from each other (see figure). Plates 2 and 5 are connected by a conductor while 1 and 3 are joined by another conductor. The junction of 1 and 3 and the plate 4 are connected to a source of constant emf V_0. Find the effective capacity of the system between the terminals of source.



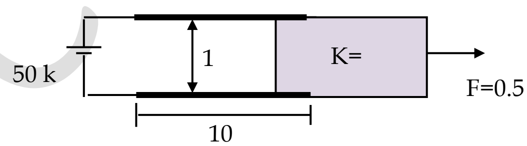
(a) $\frac{\varepsilon_0 A}{2d}$ (b) $\frac{5\varepsilon_0 A}{3d}$

(c) $\frac{3\varepsilon_0 A}{5d}$ (d) $\frac{3\varepsilon_0 A}{2d}$

2. A $20\,\text{pF}$ parallel plate capacitor with air medium is charged to $200\,\text{V}$ and then disconnected from the battery. What is the energy U_i of the capacitor? The plates are then slowly pulled apart (in a direction normal to the plate area) so that the plate separation is doubled. What is the mechanical work done in the process?

(a) 0.2μJ (b) zero (c) 0.3μJ (d) 0.4μJ

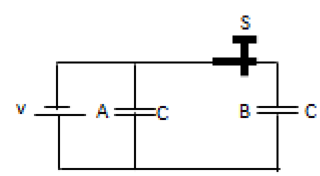
3. A dielectric slab of mass $39\,\text{g}$ is pulled out of capacitor from it when it was fully inside with a force of $0.5\,\text{N}$. Find the speed of slab when it comes out of the plates.



(a) $\sqrt{2}\text{ms}^{-1}$ (b) 2ms^{-1}

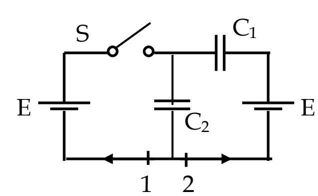
(c) $\sqrt{3}\text{ms}^{-1}$ (d) 1ms^{-1}

4. The figure shows two identical parallel-plate capacitors connected to a battery with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant (or relative permittivity). Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.



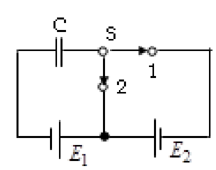
(a) $\frac{2k}{k^2+1}$ (b) 2k (c) $\frac{k}{k^2+1}$ (d) k

5. Find the ratio of the charges that will flow after the shorting of the switch S in the circuit illustrated in figure through sections 1 and 2 in the directions indicated by the arrows?



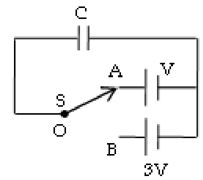
(a) $\frac{C_1+C_2}{C_1}$ (b) 2 (c) $\frac{C_1+C_2}{C_2}$ (d) $\frac{C_1}{C_2}$

6. What amount of heat will be generated in the circuit shown in figure after the switch S is shifted from position 1 to position 2?



(a) $\frac{1}{2}CE_2^2$ (b) CE_2^2 (c) $\frac{1}{2}CE_1^2$ (d) CE_1^2

7. Find the heat generated when S is switched from A to B.



(a) CV^2 (b) $2CV^2$
(c) $3CV^2$ (d) $4CV^2$

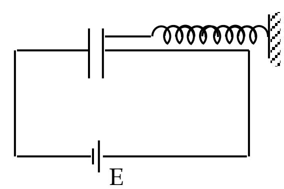
8. Two identical metal plates are given positive charges Q_1 and $Q_2 (< Q_1)$ respectively. If they are now brought close to form a parallel plate capacitor with capacitance C, the potential difference between them is

(a) $\frac{Q_1 + Q_2}{2C}$ (b) $\frac{Q_1 + Q_2}{C}$ (c) $\frac{Q_1 - Q_2}{C}$ (d) $\frac{Q_1 - Q_2}{2C}$

9. A $2\mu F$ capacitor C_1 is charged to a voltage $100V$ and a $4\mu F$ capacitor C_2 is charged to a voltage $50V$. The capacitors are then connected in parallel. What is the loss of energy due to parallel connection?

(a) $1 \cdot 7\ J$ (b) $1 \cdot 7 \times 10^{-1}\ J$ (c) $1 \cdot 7 \times 10^{-2}\ J$ (d) $1 \cdot 7 \times 10^{-3}\ J$

10. One plate of a capacitor is connected to a spring as shown in figure. Area of both the plates is A. In steady state, separation between the plates is $0.8d$ (spring was unstretched and the distance between the plates was d when the capacitor was uncharged). The force constant of the spring is approximately



(a) $\frac{6 \epsilon_0 E^2}{Ad^3}$ (b) $\frac{4 \epsilon_0 AE^2}{d^3}$ (c) $\frac{\epsilon_0 AE^3}{2d^3}$ (d) $\frac{2 \epsilon_0 AE}{d^2}$

ANSWER KEY

1. b	2. d	3. a	4. a	5. a	6. a	7. b	8. d	9. d	10. b

1. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)
   (a) $\frac{4\pi\varepsilon_0 F d^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 F e^2}{d^2}}$ (c) $\sqrt{\frac{4\pi\varepsilon_0 F d^2}{e^2}}$ (d) $\sqrt{\frac{4\pi\varepsilon_0 F d^2}{q^2}}$

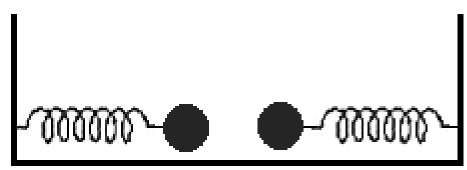
2. Sixty-four small drops of mercury, each of radius r and charge q coalesce to form a big drop. The ratio of surface charge density of each small drop to that of the big drop is
   (a) 64 : 1 (b) 1 : 64 (c) 4 : 1 (d) 1 : 4

3. Two small balls carrying charges +9 μC and -4 μC attract each other with a force F. If a charge of -5 μC is added to each one of them, then the force between the balls would become
   (a) F (b) $\frac{F}{2}$ (c) 2 F (d) $\frac{3F}{4}$

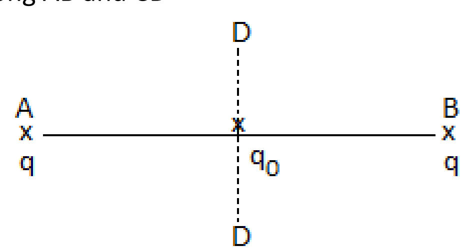
4. Two identical conducting spheres A and B are separated by a distance greater than their diameters. The spheres carry equal charges and electrostatic force between them is F. A third identical uncharged sphere C is first brought in contact with A, then with B and finally removed. As a result, the electrostatic force between A and B becomes
   (a) $\frac{F}{2}$ (b) $\frac{3F}{8}$ (c) $\frac{F}{16}$ (d) $\frac{F}{4}$

5. Two point charges placed at a certain distance r in air exert a force F on each other. The distance r' at which these charges will experience the same force in a medium of dielectric constant K is
   (a) $\frac{r}{K}$ (b) $\frac{r}{\sqrt{k}}$ (c) r$\sqrt{K}$ (d) rK

6. Two small conducting spheres are connected to the ends of the two identical springs as shown. The spacing between the spheres is 0.05 m. On charging each sphere to + 1.6 μC, the separation between the spheres doubles. The spring constant of each spring is
   (a) 46 N m^{-1} (b) 92 N m^{-1}
   (c) 23 N m^{-1} (d) 920 N m^{-1}

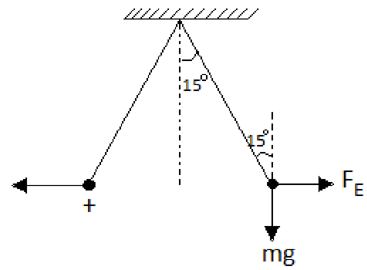


7. For the arrangement shown in the figure, mark the correct statement
   (a) If q_0 is positive, it is in stable equilibrium for displacements both along AB and CD
   (b) If q_0 is negative, it is in stable equilibrium for displacements both along AB and CD
   (c) Equilibrium is stable along AB is q_0 is positive and stable along CD if q_0 is negative
   (d) Equilibrium is stable along AB if q_0 is negative and stable along CD if q_0 is positive



8. A charge of 8.2×10^{-4} C is distributed between two spheres as q_1 and q_2 such that they repel each other with a force of 4 N, when their centres are 6 m apart in air. Then
(a) $q_1 = 700\ \mu C, q_2 = 10\ \mu C$ (b) $q_1 = 600\ \mu C, q_2 = 20\ \mu C$
(c) $q_1 = 800\ \mu C, q_2 = 20\ \mu C$ (d) $q_1 = 500\ \mu C, q_2 = 50\ \mu C$

9. Two identically charged spheres are suspended by strings of equal length. The strings make an angle of 30^0 with each other. When suspended in a liquid of density 0.8g cm^{-3}, the angle between the threads remain the same. If the density of the sphere is 1.6g cm^{-3}, the dielectric constant of the liquid is



(a) 4 (b) 2
(c) 6 (d) 8

10. Two identical conducting spheres of mass m and charge q are suspended from a point using two strings each of length L. If the spheres are in equilibrium and the angle of divergence of the two strings is small the separation between the spheres is
(a) x = $\left(\frac{2\pi\varepsilon_0 mg}{q^2 L}\right)^{\frac{1}{3}}$ (b) x = $\left(\frac{q^2 L}{2\pi\varepsilon_{0} mg}\right)^{\frac{1}{3}}$ (c) x = $\left(\frac{4\pi\varepsilon_0 mg}{q^2 L}\right)^{\frac{1}{3}}$ (d) x = $\left(\frac{4\pi L^2}{q^2 \varepsilon_0}\right)^{\frac{1}{3}}$

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	d	a	b	b	b	c	c	b	b

1. Two point charges +8q and −2q are located at x = 0 and x = L respectively. The null point along the line joining the charges and between them is at a distance x from the weaker charge. The value of x is

(a) 2L (b) 4L (c) $\frac{2L}{3}$ (d) $\frac{L}{4}$

2. An electron enters a region of uniform electric field with its initial velocity along the direction of the field. Then the electron

(a) moves along the direction of the field with increasing speed

(b) moves along the direction of the field with decreasing speed

(c) describes a circular path in a perpendicular plane

(d) moves along the direction of the field without any change in its speed.

3. A pith ball covered with tin foil having a mass m hangs by a fine silk thread l metre long in a horizontal electric field E. When the ball is given an electric charge q coulomb, it stands out d metre from the vertical line. The mass of the pith ball is given by

(a) $\frac{qE\sqrt{l^2-d^2}}{gd}$ (b) $\frac{qEl}{gd}$ (c) $\frac{qEd}{gl}$ (d) $\frac{qE\sqrt{l^2+d^2}}{gd}$

4. Two point charges 8 nC and 16 nC are placed at the corners B and C of an equilateral triangle of side 3 cm. The magnitude of the electric field at the vertex A of the triangle is

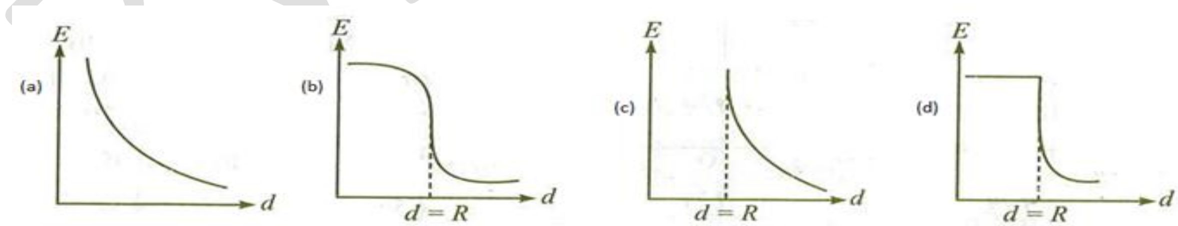
(a) $8\sqrt{7}$ X 10^4 NC^{-1} (b) $8\sqrt{7}$ X 10^{-4} NC^{-1}

(c) $8(5+\sqrt{3})10^4 NC^{-1}$ (d) $8(5+\sqrt{3})10^{-4} NC^{-1}$

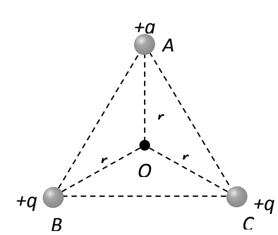
5. Point charges q, -q, 2Q and Q are placed in order at the corners A, B, C and D of the square of side 2b. If field at the midpoint CD is zero then $\frac{q}{Q}$ is

(a) 1 (b) 2 (c) $\frac{2\sqrt{2}}{5}$ (d) $\frac{5\sqrt{5}}{2}$

6. The graph that represents the variation of electric field E due to a charged spherical shell of radius R with distance d from its centre is

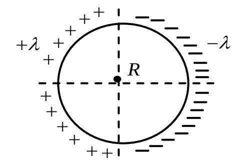


7. ABC is an equilateral triangle. Charges $+q$ are placed at each corner. The electric intensity at O will be



(a) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (c) Zero (d) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{r^2}$

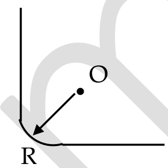
8. The intensity of electric field at the centre of a ring charged uniformly with linear charge density λ as shown in the figure is



(a) zero (b) $\frac{4k\lambda}{.R}$

(c) $\sqrt{2}\frac{k\lambda}{R}$ (d) $\frac{k\lambda}{.R}$

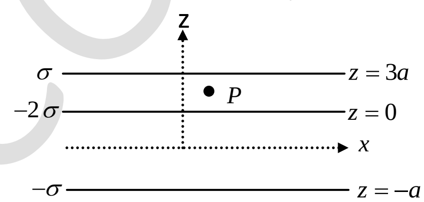
9. A thread carrying a uniform charge λ per unit length has the configuration shown in figures. Assuming a curvature radius R to be considerably less than the length of the thread, find the magnitude of the electric field strength at the point O.



(a) $\frac{\lambda\sqrt{2}}{4\pi\varepsilon_0 R}$ (b) $\frac{2\lambda}{4\pi\varepsilon_0 R}$

(c) $\frac{\lambda\sqrt{2}}{8\pi\varepsilon_0 R}$ (d) zero

10. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is:



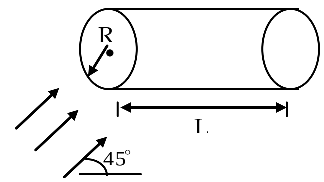
(a) $\frac{2\sigma}{\varepsilon_0}\hat{k}$ (b) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$

(c) $\frac{4\sigma}{\varepsilon_0}\hat{k}$ (d) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	b	a	a	d	c	c	b	a	d

1. A cylinder of radius R and length L in placed in a uniform electric field E_0 as shown. What is the flux through the cylinder?

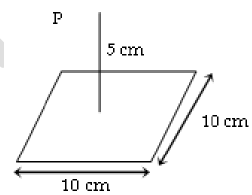


(a) $\pi R^2 E_0$ (b) $2\pi RLE_0$ (c) zero (d) $2\pi R^2 E_0$

2. The inward and outward electric flux for a closed surface in units of $N\text{-}m^2/C$ are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface is [where $\varepsilon_0 =$ permittivity constant]

(a) 4×10^3 C (b) -4×10^3 C (c) $\frac{(-4\times10^3)}{\varepsilon}$ C (d) $-4\times10^3\,\varepsilon_0$ C*

3. A point charge $+10\mu\,C$ is at a distance $5\,\text{cm}$ directly above the centre of a square of side 10cm as shown in the figure. What is the magnitude of the electric flux through the square (in $\text{N m}^2\ \text{c}^{-1}$)?

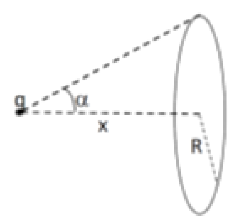


(a) 1.88×10^5 (b) zero (c) 2.46×10^5 (c) 3.88×10^5

4. Electric flux through a surface of area 100 m^2 lying in the xy plane is (in V-m) if $\vec{E}=\hat{i}+\sqrt{2}\hat{j}+\sqrt{3}\hat{k}\ \text{Vm}^{-1}$ is

(a) 100 (b) 141.4 (c) 173.2 (d) 200

5. A point charge q lies at one corner of an imaginary cube. Find the flux penetrating each of the three faces that join at the corner where the charge is located and the flux penetrating each of the other three faces.

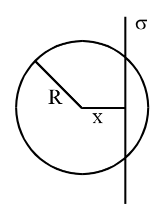


(a)zero, $\frac{q}{\varepsilon_0}$ (b) zero, $\frac{q}{8\varepsilon_0}$ (c) zero, $\frac{q}{24\varepsilon_0}$ (d) $\frac{q}{6\varepsilon_0}, \frac{q}{6\varepsilon_0}$

6. A point charge q is located at a distance x from the centre of an imaginary circle of radius R as shown. Find the flux due to q through the circle.

(a)zero (b) $\frac{q}{\varepsilon_0}\cos\alpha$ (c) $\frac{q}{\varepsilon_0}(1-\cos\alpha)$ (d) $\frac{q}{2\varepsilon_0}(1-\cos\alpha)$

7. An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its centre, as shown in the figure. The electric flux through the Gaussian surface is

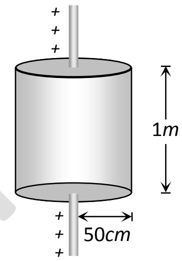


(a) $\frac{\pi R^2\sigma}{\varepsilon_0}$ (b) $\frac{2\pi(R^2-x^2)\ \sigma}{\varepsilon_0}$ (c) $\frac{\pi(R-x)^2\sigma}{\varepsilon_0}$ (d) $\frac{\pi(R^2-x^2)\ \sigma}{\varepsilon_0}$

8. In a region of space, the electric field is in the x direction and is given as $\vec{E} = E_0 x \hat{i}$. Consider an imaginary cubical volume of edge a, with its edges parallel to the axes of coordinates. The charge inside this volume is:

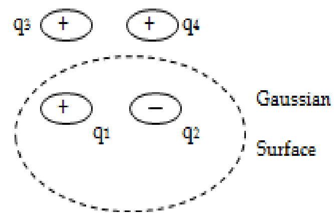
(a) zero (b) $\varepsilon_0 E_0 a^3$ (c) $2\varepsilon_0 E_0 a^3$ (d) $3\varepsilon_0 E_0 a^3$

9. Electric charge is uniformly distributed along a long straight wire of radius 1mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50 cm and length 1m symmetrically encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is



(a) $\frac{Q}{\varepsilon_0}$ (b) $\frac{100Q}{\varepsilon_0}$ (c) $\frac{10Q}{(\pi\varepsilon_0)}$ (d) $\frac{100Q}{(\pi\varepsilon_0)}$

10. Consider the Gaussian surface that surrounds part of the charge distribution shown in figure. Then the contribution to the electric field at a given point on the surface arises from charges:



(a) q_1 and q_2 only (b) q_3 and q_4 only
(c) all the charges (d) none of the above.

ANSWER KEY

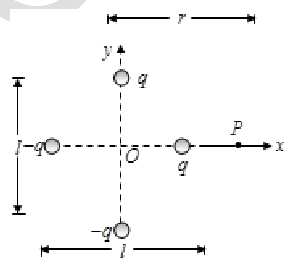
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	d	a	c	c	d	d	b	b	b

1. Two particles A and B, having opposite charges $2.0\times10^{-6}\,\text{C}$ and $-2.0\times10^{-6}\,\text{C}$, are placed at a separation of 1 μm. Calculate the electric field at a point on the axis of the dipole 1m away from the centre (in NC^{-1}).
   (a) 36 (b) 3.6 (c) 0.36 (d) 0.036

2. Two charges $\pm2\times10^{-6}\text{C}$ separated by $1\mu\text{m}$ comprise a dipole. The dipole is placed in a uniform electric field of strength 20kVm^{-1} such that it makes an angle of 60^0 with the dipole moment. Find the work done (in nJ) in rotating the dipole such that the angle becomes 120^0.
   (a)40 (b) 80 (d) zero (d) 60

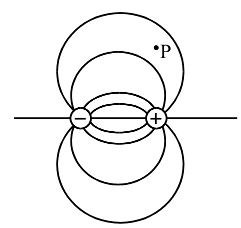
3. A small electric dipole of dipole moment p is placed at origin with its dipole moment directed along positive $x-$axis. Find the locus of points at which electric field is along the $y-$axis.
   (a) $y=\pm x$ (b) $y=\pm\sqrt{2}x$ (d) $y=\pm2x$ (d) $y=\pm3x$

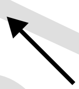
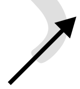
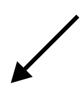
4. Charges are arranged as shown in figure. A point P is located at distance r from the centre of the configuration. Assuming $r>>l$, the field at point P is



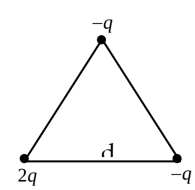
   (a) is of magnitude $\dfrac{2\sqrt{5}ql}{4\pi\varepsilon_0 r^3}$
   (b) is of magnitude $\dfrac{\sqrt{5}ql}{4\pi\varepsilon_0 r^3}$
   (c) makes an angle $\tan^{-1}(2)$ with x-axis
   (d) makes an angle $\tan^{-1}\left(\dfrac{1}{2}\right)$ with x-axis

5. Figure shows the electric field lines around an electric dipole. Which of the arrows best represents the electric field at point P?



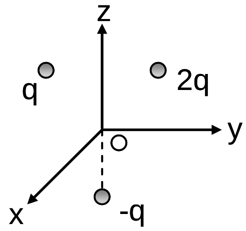
   (a)  (b)  (c)  (d) 

6. Three charges are arranged on the vertices of an equilateral triangle as shown in figure. Find the dipole moment of the combination.



   (a) qd (b) 2qd (c) 3qd (d) $\sqrt{3}$qd

7. Three point charges $2q, q$ and $-q$ are located respectively at $(0,a,a,),(0,-a,a)$ and $(0,0,-a)$ as shown. The dipole moment of this distribution is



(a) $2qa$ in the yoz plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with $z-$axis
(b) $\sqrt{17}qa$ in the yoz plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with $z-$axis
(c) $\sqrt{5}qa$ in the xoy plane at $\tan^{-1}(4)$ with $y-$axis
(d) $4qa$ in the xoy plane at $\tan^{-1}(4)$ with $y-$axis.

8. The dipole moment of a system of charge +q distributed uniformly on an arc of radius R subtending an angle $\frac{\pi}{2}$ at its centre where another charge -q is placed is :

(a) $\frac{2\sqrt{2}qR}{\pi}$ (b) $\frac{\sqrt{2}qR}{\pi}$ (c) $\frac{qR}{\pi}$ (d) $\frac{2qR}{\pi}$

9. A dipole having dipole moment $'P'$ is kept very close to a charged ring carrying charge Q and radius R. If the dipole is at a distance $x(<< R)$ along the axis from the centre of the ring, then the force experienced by the dipole is

(a) $\frac{KQP}{R^3}$ (b) $\frac{2KQP}{R^3}$ (c) $\frac{KQP}{\left(R^2+x^2\right)^{3/2}}$ (d) $\frac{KQP}{\left(R^2-x^2\right)^{3/2}}$

10. A dipole consists of two particles one with charge +10mC and mass 1kg and the other with charge –10mC and mass 2kg separated by a distance of 3m. For small oscillations about its equilibrium position, the angular frequency, when placed in a uniform electric field of 20kV/m is

(a) 0.1rad/s (b) 1.1 rad/s (c) 10 rad/s (d) 2.5rad/s

ANSWER KEY

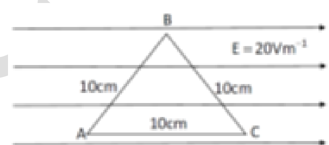
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
d	a	b	b, c	b	d	b	a	a	c

1. An infinite number of charges each equal to q and alternatively positive and negative are placed along the x axis at $x=1, x=2, x=4, x=8$ and so on. (a) Find the potential at the point $x=0$ due to this set of charges.
(a) $\frac{3Q}{4\pi\varepsilon_0}$ (b) $\frac{Q}{2\pi\varepsilon_0}$ (c) $\frac{Q}{6\pi\varepsilon_0}$ (d) zero

2. In a regular polygon of n sides, each corner is at a distance r from the centre. Identical charges are placed at (n – 1) corners. At the centre, the intensity is E and the potential is V. The ratio V/E has magnitude.
(a) r n (b) r (n – 1) (c) (n – 1)/r (d) r(n – 1)/n

3. Two electric charges $q_1=-2q$ and $q_2=q$ are placed at a distance $l=6a$ apart. Find the locus of points in the plane of the charge where the electric potential is zero (Take centre of the distribution as the origin).
(a) $(x-5a)^2+y^2=16a^2$ (b) $x^2+y^2=16a^2$ (c) $2x+3y=4a$ (c) none

4. The figure shows there points A, B and C in a uniform Electric field. The value of $V_{BC}-V_{CA}$ is ($V_{BC}=V_B-V_C$):



(a) 5V (b) 3V
(c) -5V (d) -3V

5. The potential at a point $(x,0,0)$ is given by $V=\left(\frac{1000}{x}+\frac{1500}{x^2}+\frac{500}{x^3}\right)$. Find the field intensity at the point where $x=1m$.
(a) $E_x=5500\hat{i}Vm^{-1}$ (b) $E_x=55\hat{i}Vm^{-1}$ (c) $E_x=550\hat{i}Vm^{-1}$ (d) $E_x=5.5\hat{i}Vm^{-1}$

6. The electric field is given by $\vec{E}=3\hat{i}+4\hat{j}+5\hat{k}$. Find the p.d between the points (1,1,2) and (2,3,4).
(a)21V (b) -21V (c) 32 V (d) -32V

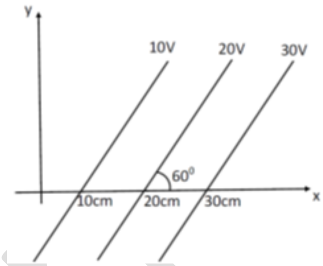
7. An electric field is given by $\vec{E}=\left(y\hat{i}+x\hat{j}\right)N/C$. The work done in moving a 1C charge from $\vec{r_A}=\left(2\hat{i}+2\hat{j}\right)m$ to $\vec{r_B}=\left(4\hat{i}+2\hat{j}\right)m$ is:
(a) 4 J (b) -4 J (c) 8 J (d) Zero

8. Determine the potential $\varphi(x,y,z)$ of an electric field $E=ay\hat{i}+(ax+bz)\hat{j}+by\hat{k}$ where a and b are constants $\hat{i},\hat{j},\hat{k}$ are the unit vectors of the axes x,y,z.
(a) $\varphi=-y(ax+bz)+$ const. (b) $\varphi=y(ax+bz)+$ const.
(c) $\varphi=-y^2(ax+bz)+$ const. (d) $\varphi=-y\left(ax^2+bz^2\right)+$ const.

9. The equation of an equipotential line in an electric field is y = 2x, then the electric field strength vector at (1, 2) may be

(a) $4\hat{i}+3\hat{j}$ (b) $4\hat{i}+8\hat{j}$ (c) $8\hat{i}+4\hat{j}$ (d) $-8\hat{i}+4\hat{j}$

10. A group of equipotential surfaces in shape of parallel planes are as shown in the figure. The electric field in the region is given by (in NC^{-1}):



(a) $100\hat{i}+\frac{100}{\sqrt{3}}\hat{j}$ (b) $-100\hat{i}+\frac{200}{\sqrt{3}}\hat{j}$

(c) $-100\hat{i}+\frac{100}{\sqrt{3}}\hat{j}$ (d) $100\hat{i}-\frac{100}{\sqrt{3}}\hat{j}$

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	b	a	b	a	b	b	a	d	c

1. Three concentric shells A, B and C have radii R, 2R and 3R. A is given a charge q and C is given a charge 2q and B is earthed. The charges on the inner and outer surfaces of A, B and C are

(a)

	A	B	C
Inner	0	−q	$\frac{2q}{3}$
Outer	q	$-\frac{2q}{3}$	$\frac{4q}{3}$

(b)

	A	B	C
Inner	0	+q	$\frac{2q}{3}$
Outer	−q	$-\frac{2q}{3}$	$\frac{4q}{3}$

(c)

	A	B	C
Inner	0	−q	$\frac{4q}{3}$
Outer	q	$-\frac{4q}{3}$	$\frac{2q}{3}$

(d)

	A	B	C
Inner	0	−q	$-\frac{2q}{3}$
Outer	q	$\frac{2q}{3}$	$\frac{6q}{3}$

2. Answer the previous question if everything else remains the same and A and B are connected by means of a conducting wire.

(a)

	A	B	C
Inner	0	+q	$\frac{2q}{3}$
Outer	−q	$-\frac{2q}{3}$	$\frac{4q}{3}$

(b)

	A	B	C
Inner	0	$-\frac{6q}{11}$	$\frac{18q}{11}$
Outer	$\frac{6q}{11}$	$-\frac{18q}{11}$	$\frac{9q}{11}$

(c)

	A	B	C
Inner	0	−q	$\frac{q}{3}$
Outer	q	$-\frac{q}{3}$	$\frac{5q}{3}$

(d)

	A	B	C
Inner	0	$\frac{6q}{11}$	$\frac{30q}{11}$
Outer	$-\frac{6q}{11}$	$-\frac{30q}{11}$	$-\frac{8q}{11}$

3. The kinetic energy of a charged particle decreases by $10\,J$ as it moves from a point at potential $100\,V$ to a point at potential $200V$. Find the magnitude of the charge on the particle.
(a) $0.1\,C$ (b) 0.2 C (c) 1 C (d) 2 C

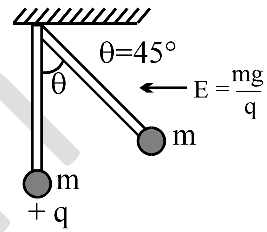
4. A charge of $100\mu c$ is fixed is space. A light particle of mass $4gm$ and charge $1\mu c$ is projected towards $100\mu c$ charge with a velocity of $50ms^{-1}$. The initial separation is $\left(\frac{90}{13}\right)cm$ then the distance of closest approach is
(a) $10mm$ (b) $2.5mm$ (c) $8.4mm$ (d) $50mm$

5. In a certain region of space, electric potential V is given by $V = ax^2 + ay^2 + 2az^2$ (where a is a constant of proper dimensions). A $2\mu C$ test charge moves from $(0.1\,m, 0.1\,m)$ to the origin and in the process the work done by the field is 5×10^{-5} J. What is the value of a ?
(a) $125V/m^2$ (b) $1250V/m^2$ (c) $12.5V/m^2$ (d) $12500V/m^2$

6. Two identical particles of mass m carry a charge Q each. Initially one is at rest on a smooth horizontal plane and the other is projected along the plane directly towards first particle from a large distance with speed v . The closest distance of approach be

(a) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{mv}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{4Q^2}{mv^2}$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{2Q^2}{mv^2}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{3Q^2}{mv^2}$

7. In space of horizontal Electric field $E=\frac{mg}{q}$ exists as shown in figure and a mass m attached at the end of a light rod. If mass m is released from the position shown in figure find the angular velocity of the rod when it passes through the bottom most position

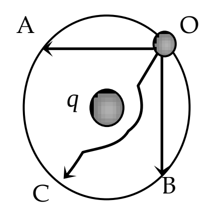


(a) $\sqrt{\frac{g}{l}}$ (b) $\sqrt{\frac{2g}{l}}$ (c) $\sqrt{\frac{3g}{l}}$ (d) $\sqrt{\frac{5g}{l}}$

8. An electric dipole has a dipole moment p . The work done in moving a point charge q_0 from a point P at a distance d on the axis of the dipole to a point Q at a distance $2d$ on the axis of the dipole is

(a) $\frac{3kPq_0}{4d^2}$ (b) $\frac{Kq_0p}{d^2}$ (c) $\frac{3k_0P}{12}$ (d) $\frac{4}{3}\frac{kq_0P}{d^2}$

9. Work done in transferring a point charge from O to A,B and C are W_1,W_2 and W_3 respectively. Then



(a) $W_1 > W_2 > W_3$
(b) $W_1 < W_2 < W_3$
(c) $W_1 < W_2 > W3$
(d) $W_1 = W_2 = W_3 = 0$

10. Two protons each of mass m are held at rest at a distance of $1\,m$ in air. If k is electrostatic force constant, the find velocity acquired by each proton after a long time once released is

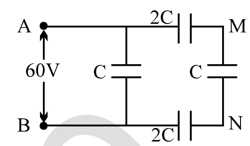
(a) $e\sqrt{\frac{k}{m}}$ (b) $2e\sqrt{\frac{k}{m}}$ (c) $\frac{e}{2}\sqrt{\frac{k}{m}}$ (d) zero

<u>ANSWER KEY</u>

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	b	a	d	b	b	b	a	d	a

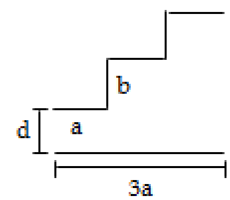
1. A capacitor of capacitance 1 mF with stands the maximum voltages 6 KV while a capacitor of capacitance 2.0 mF with stands the maximum voltage = 4KV. if the two capacitors are connected in series, then the two capacitors combined can take up a maximum voltage of
(a) 2.4 KV (b) 5 KV (c) 9 KV (d) 10 KV

2. In the circuit shown, a potential difference of 60V is applied across AB. The potential difference between the point M and N is



(a) 10 V (b) 15 V
(c) 20 V (d)30 V

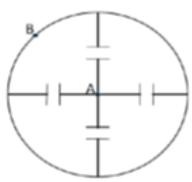
3. A capacitor is made of a flat plate of area A and a second plate having a stair-like structure as shown in figure. The width of each stair is a and the height is b. Find the capacitance of the assembly



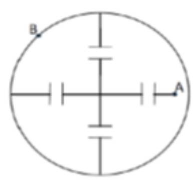
(a) $\frac{\varepsilon_0 A\left(3d^2+6bd+2b^2\right)}{3d(d+b)(d+2b)}$ (b) $\frac{\varepsilon_0 A\left(3d^2+6bd+2b^2\right)}{d(d+b)(d+2b)}$

(c) $\frac{\varepsilon_0 A\left(3d^2+6bd+b^2\right)}{3d(d+b)(d+b)}$ (d) $\frac{\varepsilon_0 A\left(3d^2+4bd+2b^2\right)}{3d(d+2b)(d+2b)}$

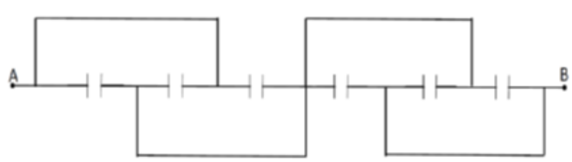
4. Unless otherwise mentioned all the capacitors have a capacitance c. Find the effective capacitance between A and B:



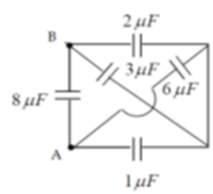
(i)



(ii)



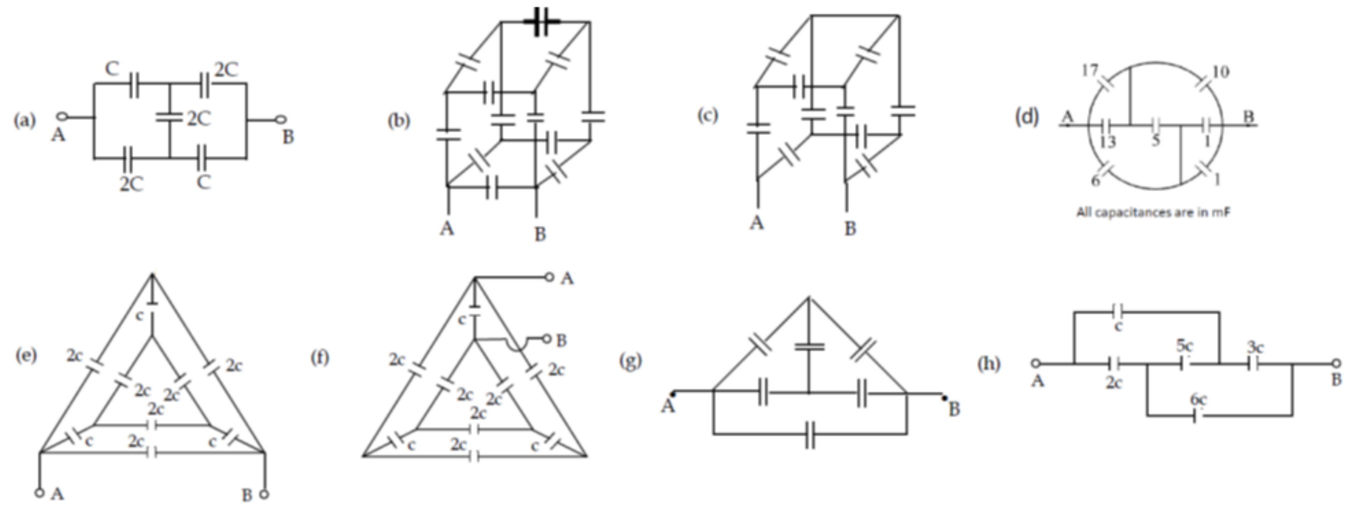
(iii)



(iv)

(i) 4c (ii) $\frac{3c}{4}$ (iii) $\frac{3c}{2}$ (iv) $\frac{121}{12}\mu F$

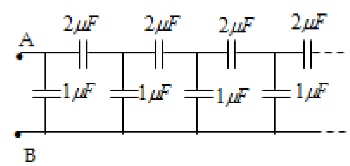
5. Unless otherwise mentioned all the capacitors have a capacitance c . Find the effective capacitance between A and B:



(a) $\frac{10c}{7}$ (b) $\frac{12c}{7}$ (c) $\frac{8c}{9}$ (d) 9mF (e) $\frac{3c}{7}$ (f) 2c

(g) 2c (h) $\frac{9c}{4}$

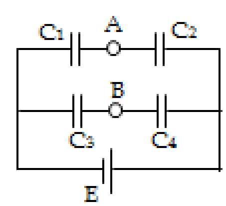
6. Find the equivalent capacitance of the infinite ladder shown in figure between the points A and B



(a) 2μF (b) 3μF

(c) 0.5μF (d) 1μF

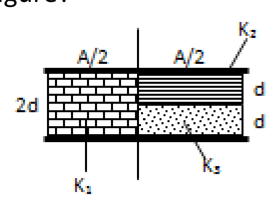
7. Determine the potential difference $\phi_A - \phi_B$ between points A and B of the circuit shown in figure.



(a) $\frac{(C_2C_3 - C_1C_4)E}{(C_1 + C_2)(C_3 + C_4)}$ (b) zero

(C) $\frac{(C_1C_3 - C_2C_4)E}{(C_1 + C_2)(C_3 + C_4)}$ (d) $\frac{(C_2C_3 - C_1C_4)E}{(C_1 - C_2)(C_3 - C_4)}$

8. What is the capacitances of the capacitor, of plate area A, shown in figure?



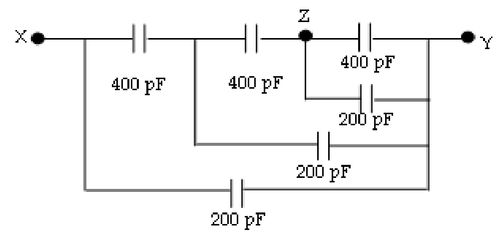
(a) $\frac{\varepsilon_0 A}{4d}\left(k_1 + \frac{2k_2k_3}{k_2 + k_3}\right)$ (b) $\frac{\varepsilon_0 A}{2d}\left(k_1 + \frac{k_2k_3}{k_2 + k_3}\right)$

(c) $\frac{\varepsilon_0 A}{4d}\left(k_1 + \frac{k_2k_3}{k_2 + k_3}\right)$ (d) $\frac{\varepsilon_0 A}{d}\left(k_1 + \frac{2k_2k_3}{k_2 + k_3}\right)$

9. In a system of two concentric shells, if the inner sphere of radius a is earthed and the outer sphere of radius b is given a charge $+q$, then the effective capacitance of the system is

(a) $4\pi\varepsilon_0(b-a)$ (b) $4\pi\varepsilon_0 ab$ (c) $4\pi\varepsilon_0\left\{\frac{ab}{b-a}\right\}$ (d) $4\pi\varepsilon_0\left\{\frac{b^2}{b-a}\right\}$

10. In the network of capacitors shown below, a p.d. of 300 volts is applied between X and Y. What is the p.d. across X and Z?



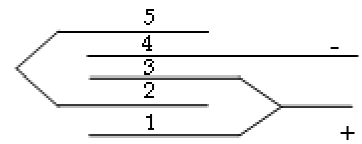
(a)197.5 V (b)212 V

(c)157.5V (d)243 V

ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	d	b			a	a	a	d	d

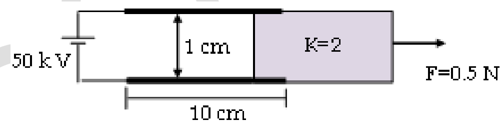
1. Five identical conducting plates 1,2,3,4 and 5 are fixed parallel equidistant from each other (see figure). Plates 2 and 5 are connected by a conductor while 1 and 3 are joined by another conductor. The junction of 1 and 3 and the plate 4 are connected to a source of constant emf V_0. Find the effective capacity of the system between the terminals of source.



(a) $\frac{\varepsilon_0 A}{2d}$ (b) $\frac{5\varepsilon_0 A}{3d}$ (c) $\frac{3\varepsilon_0 A}{5d}$ (d) $\frac{3\varepsilon_0 A}{2d}$

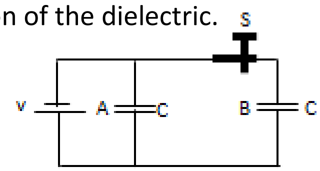
2. A $20\,\text{pF}$ parallel plate capacitor with air medium is charged to $200\,\text{V}$ and then disconnected from the battery. The plates are then slowly pulled apart (in a direction normal to the plate area) so that the plate separation is doubled. What is the mechanical work done in the process?
(a) $0.2\mu J$ (b) zero (c) $0.3\mu J$ (d) $0.4\mu J$

3. A dielectric slab of mass $39\,\text{g}$ is pulled out of capacitor from it when it was fully inside with a force of $0.5\,\text{N}$. Find the speed of slab when it comes out of the square plates.



(a) $\sqrt{2}\text{ms}^{-1}$ (b) 2ms^{-1}
(c) $\sqrt{3}\text{ms}^{-1}$ (d) 1ms^{-1}

4. The figure shows two identical parallel-plate capacitors connected to a battery with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant (or relative permittivity). Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.



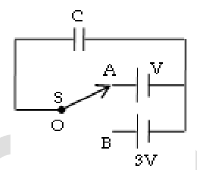
(a) $\frac{2k}{k^2+1}$ (b) $2k$ (c) $\frac{k}{k^2+1}$ (d) k

5. A capacitor is charged to $200\,V$ and possesses a charge $0.1\,C$. When discharged, it would release an energy of
(a) $1\ J$ (b) $2\ J$ (c) $10\ J$ (d) $20\ J$

6. Two capacitors of capacitance C and $2C$, are charged to potential differences V ad $2V$ respectively. If the two positive plates are connected together and the two negative plates are connected together, then this system of capacitance
(a) gains energy but loses charge (b) gains charge but loses energy
(c) loses both energy and charge (d) loses energy but charge remains constant

7. A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at $x=0$ and positive plate is at $x=3d$. The slab is equidistant from the plates. The capacitor is given some charge. As x goes from 0 to $3d$
(a)the electric potential increases at first, then decreases and again increase
(b) the electric potential decreases continuously
(c)the direction of the electric field remains the same
(d)the magnitude of the electric field remains the same

8. Find the heat generated when S is switched from A to B.



(a) CV^2 (b) $2CV^2$
(c) $3CV^2$ (d) $4CV^2$

9. Two identical metal plates are given positive charges Q_1 and $Q_2 (< Q_1)$ respectively. If they are now brought close to form a parallel plate capacitor with capacitance C, the potential difference between them is
(a) $\frac{Q_1+Q_2}{2C}$ (b) $\frac{Q_1+Q_2}{C}$ (c) $\frac{Q_1-Q_2}{C}$ (d) $\frac{Q_1-Q_2}{2C}$

10. A $2\,\mu F$ capacitor C_1 is charged to a voltage $100V$ and a $4\,\mu F$ capacitor C_2 is charged to a voltage $50V$. The capacitors are then connected in parallel. What is the loss of energy due to parallel connection?
(a) $1\cdot 7\ J$ (b) $1\cdot 7\times 10^{-1}\ J$ (c) $1\cdot 7\times 10^{-2}\ J$ (d) $1\cdot 7\times 10^{-3}\ J$

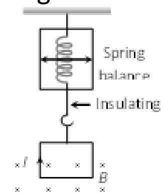
ANSWER KEY

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
a	d	a	a	c	d	c	b	d	d

Magnetism

PHYSICS

1. A square loop of side a hangs from an insulating hanger of spring balance. The magnetic field of strength B occurs only at the lower edge. It carries a current I. Find the change in the reading of the spring balance if the direction of current is reversed



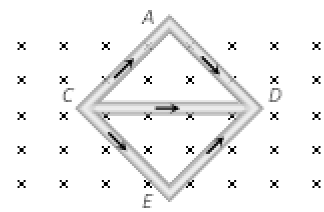
(a) IaB (b) 2 IaB

(c) $\frac{IaB}{2}$ (d) $\frac{3}{2}IaB$

2. A horizontal rod of mass 10 gm and length 10 cm is placed on a smooth plane inclined at an angle of 60° with the horizontal, with the length of the rod parallel to the edge of the inclined plane. A uniform magnetic field of induction B is applied vertically downwards. If the current through the rod is 1.73 ampere, then the value of B for which the rod remains stationary on the inclined plane is

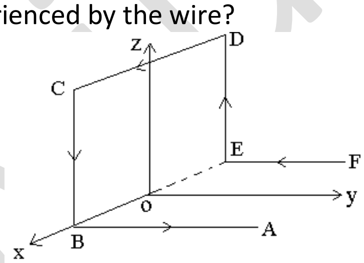
(a) 1.73 Tesla (b) $\frac{1}{1.73}$ Tesla (c) 1 Tesla (d) None of the above

3. Same current i = 2A is flowing in a wire frame as shown in figure. The frame is a combination of two equilateral triangles ACD and CDE of side 1m. It is placed in uniform magnetic field B = 4T acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is



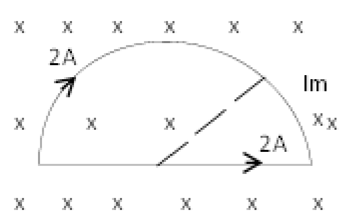
(a) 24 N
(b) Zero
(c) 16 N
(d) 8 N

4. A wire ABCDEF (with each side of length L) bent as shown in figure. and carrying a current I is placed in uniform magnetic field B parallel to the positive y-direction. What is the magnitude and direction of the force experienced by the wire?



(a) BIL along positive z-direction (b) BI^2/L along positive z-direction
(c) BIL along negative z-direction (d) BL/I along negative z-direction

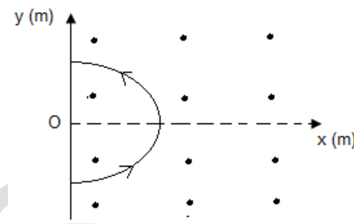
5. In the figure shown a semi-circular wire loop is placed in uniform field of 1 T. The plane of the loop is perpendicular to the field. The magnetic force on the loop is



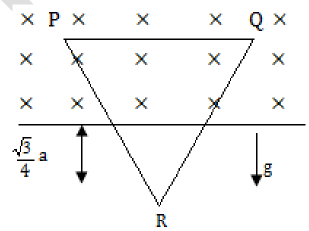
(a) 2N (b) 4N
(c) 8N (d) zero

6. A wire of mass 100 g is carrying a current of 2A towards increasing x in the form of y = x2(-2m≤x≤+2m). This wire is placed in a magnetic field $\vec{B} = -0.02\hat{k}$ tesla. The acceleration of the wire (in m/s2) is
   (a) -1.6 $\hat{j}$ (b) -3.2 $\hat{j}$ (c) 1.6 $\hat{j}$ (d) zero

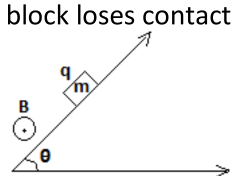
7. A wire carrying a current of 3 A is bent in the form of a parabola y2 = 4 – x as shown in figure, where x and y are in metre. The wire is placed in a uniform magnetic field $\vec{B} = 5\hat{k}$ tesla. The force acting on the wire is
   (a) 60 $\hat{\imath}$ N
   (b) -60 $\hat{\imath}$ N
   (c) 30 $\hat{\imath}$ N
   (d) -30 $\hat{\imath}$ N



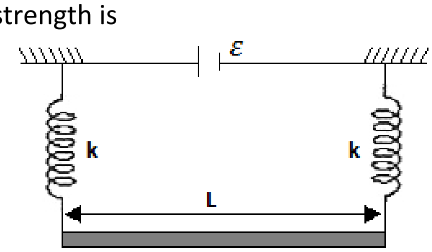
8. An equilateral triangle frame PQR of mass M and side a is kept under the influence of magnetic force due to inward perpendicular magnetic field B and gravitational field as shown in fig. The magnitude and direction of current in the frame so that the frame remains at rest is
   (a) I = $\frac{2Mg}{aB}$, $anticlockwise$ (b) I = $\frac{2Mg}{aB}$, $clockwise$
   (c) I = $\frac{Mg}{aB}$, $anticlockwise$ (d) I = $\frac{Mg}{aB}$, $clockwise$



9. A block of mass m & charge q is released on a long smooth inclined plane magnetic field B is constant, uniform, as shown. Find the time from start when block loses contact with the surface.
   (a) $\frac{m\cos\theta}{qB}$ (b) $\frac{m\,coesec\,\theta}{qB}$
   (c) $\frac{m\cot\theta}{qB}$ (d) non



10. A straight rod of mass m and length L is suspended from the identical spring as shown in the figure. The spring stretched by a distance of X_0 due to the weight of the wire. The circuit has total resistance RΩ. When the magnetic field perpendicular to the plane of the paper is switched on, springs are observed to extend further by the same distance. The magnetic field strength is
(a) $\frac{mgR}{\varepsilon L}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$
(b) $\frac{mgR}{2\varepsilon x_0}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$
(c) $\frac{mgR}{\varepsilon L}$; $directed\ into\ from\ the\ plane\ of\ the\ paper$
(d) $\frac{mgR}{\varepsilon L}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$



ANSWER KEY

1. b	2. c	3. a	4. a	5. c	6. c	7. a	8. b	9. c	10. a

1. An electron is projected at an angle θ in a uniform magnetic field .if pitch of helical path is equal to the radius then the angle of projection θ is
(a) $\tan^{-1}\pi$ (b) $\tan^{-1}\pi$ (c) $\cot^{-1}\pi$ (d) $\cot^{-1} 2\pi$

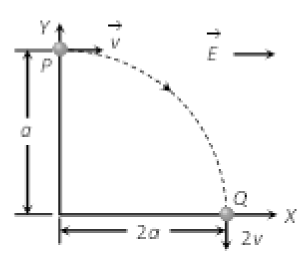
2. A particle of specific charge $\frac{q}{m} = \pi x 10^{10} C/kg$ is projected from the origin along the positive x-axis with a velocity of 10^5 m/s in a uniform magnetic field $B = -2x10^{-3}\hat{k}$ tesla.
(a) The particle will move in the anticlockwise sense about the positive Z- axis
(b) The particle will move in the clockwise sense about the positive Z- axis
(c) The center of the circle lies on the y –axis
(d) The center of the circle on the x- axis

3. There ions H^+, He^+ and O^{+2} having same kinetic energy pass through a region in which there is a uniform magnetic field perpendicular to their velocity, then:
(a) H^+ *will be least deflected.* (b) He^+ *and* O^{+2} *will be deflected equally.*
(c) O^{+2} *will be deflected most.* (d) all will be deflected equally.

4. A particle of charge per unit mass α is released from origin with velocity $\vec{v} = v_0\hat{i}$ in a magnetic field $\vec{B} = -B_0\hat{k}$ for $x \le \frac{\sqrt{3}}{2}\frac{v_o}{B_O\alpha}$, And $\vec{B} = 0$ for $x > \frac{\sqrt{3}}{2}\frac{v_o}{B_O\alpha}$ The x co-ordinate of the particle at time t $\left(> \frac{\pi}{3B_O\alpha}\right)$

(a) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + \frac{\sqrt{3}}{2}V_O\left(t - \frac{\pi}{B_O\alpha}\right)$ (b) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\left(t - \frac{\pi}{3B_O\alpha}\right)$
(c) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\frac{1}{2}\left(t - \frac{\pi}{3B_O\alpha}\right)$ (d) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\frac{1}{2}$

5. A particle of charge +q and mass m moving under the influence of a uniform electric field $E\hat{i}$ and a uniform magnetic field $B\hat{k}$ follows trajectory from P to Q as shown in figure. The velocities at P and Q are $v\hat{i}$ and $-2v\hat{j}$ respectively. Which of the following statement(s) is/are correct

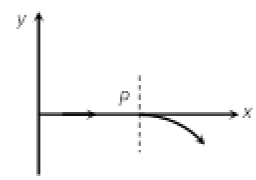


(a) E = $\frac{3}{4}\frac{mv^2}{qa}$
(b) Rate of work done by electric field at P is $\frac{3}{4}\frac{mv^3}{a}$
(c) Rate of work done by electric field at P is zero
(d) Rate of work done by both the fields at Q is zero

6. An ionized gas contains both positive and negative ions. If it is subjected simultaneously to an electric field along the +x direction and a magnetic field along the +z direction, then
   (a) Positive ions deflect towards +y direction and negative ions towards –y direction
   (b) All ions deflect towards +y direction
   (c) All ions deflect towards –y direction
   (d) Positive ions deflect towards –y direction and negative ions towards +y direction

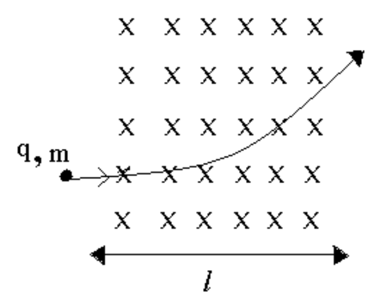
7. A particle of mass m and charge q moves with a constant velocity v along the positive x direction. It enters a region containing a uniform magnetic field B directed along the negative z direction, extending from x = a to x = b. The minimum value of v required so that the particle can just enter the region $x > b$ is
   (a) $qb\,B/m$ (b) $q(b-a)B/m$ (c) $qa\,B/m$ (d) $q(b+a)B/2m$

8. For a positively charged particle moving in a x-y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x-y plane and is found to be non-circular. Which one of the following combinations is possible



   (a) $\vec{E}=0;\vec{B}=b\hat{i}+c\hat{k}$ (b) $\vec{E}=a\hat{i};\vec{B}=c\hat{k}+a\hat{i}$
   (c) $\vec{E}=0;\vec{B}=c\hat{j}+b\hat{k}$ (d) $\vec{E}=a\hat{i};\vec{B}=c\hat{k}+b\hat{j}$

9. A particle of mass 'm' and charge 'q' is projected into a region of thickness 'l'containing uniform magnetic induction field 'B' pointing into the plane of the paper, transversely with a momentum of $2qlB$ as shown in the figure, then the correct statements



   (a) The particle is deflected by 30^0 passing through the field region
   (b) The particle spends a time internal of $\frac{\pi m}{6qB}$ inside the field region
   (c) The velocity of the particle remains constant as it passes through the field
   (d) The particle is positively charged

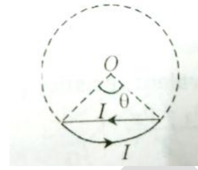
10. A particle of mass M and charge Q moving with velocity $\vec{v}$ describes a circular path of radius R when subjected to a uniform transverse magnetic field of induction B. The work done by the field when the particle completes one full circle is
   (a) $BQv2\pi R$ (b) $\left(\frac{Mv^2}{R}\right)2\pi R$ (c) Zero (d) $BQ2\pi R$

<u>ANSWER KEY</u>

1. b	2. c	3. b	4. b	5. a,d
6. c	7. b	8. b	9. a,b,d	10. c

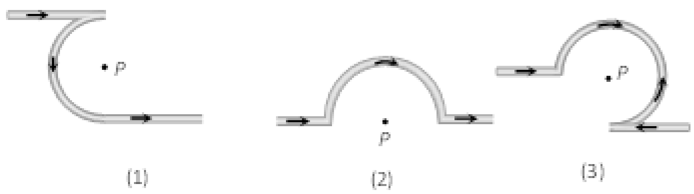
1. Three infinitely long straight wires are positioned along the x,y and z axis. If each wire carries the current I along the respective negative axis, then the magnetic induction at the point (d,0,0) is
   (a) $\frac{\mu_o i}{2\pi r}(\hat{j}-\hat{k})$ (b) $\frac{\mu_o i}{2\pi r}(-\hat{j}+\hat{k})$ (c) $\frac{\mu_o i}{2\pi r}(-\hat{j}-\hat{k})$ (d) $\frac{\mu_o i}{2\pi r}(\hat{j}+\hat{k})$

2. The fig. shows a small loop carrying a current I. the curved portion is an arc of circle of radius R and the straight portion is a chord to the same circle subtending an angle θ . The magnetic induction at the center O is



   (a) Zero
   (b) always inwards irrespective of the value of θ
   (c) Inwards as long as θ is less than πα
   (d) always outwards irrespective of the value of θ

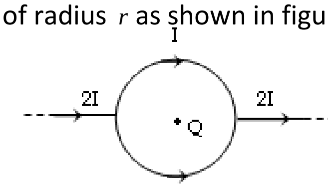
3. The magnetic field at the centre of a circular coil of radius r is π times that due to a long straight wire at a distance r from it, for equal currents. Figure here shows three cases : in all cases the circular part has radius r and straight ones are infinitely long. For same current the B field at the centre P in cases 1, 2, 3 have the ratio



   (a) $\left(-\frac{\pi}{2}\right):\left(\frac{\pi}{2}\right):\left(\frac{3\pi}{4}-\frac{1}{2}\right)$ (b) $\left(-\frac{\pi}{2}+1\right):\left(\frac{\pi}{2}+1\right):\left(\frac{3\pi}{4}+\frac{1}{2}\right)$
   (c) $-\frac{\pi}{2}:\frac{\pi}{2}:3\frac{\pi}{4}$ (d) $\left(-\frac{\pi}{2}-1\right):\left(\frac{\pi}{2}-\frac{1}{4}\right):\left(\frac{3\pi}{4}+\frac{1}{2}\right)$

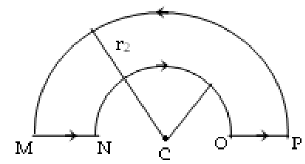
4. Two identical coils are placed co-axially so that the separation between their centres is equal to the radius of either of them. If the current in each coil is $'I'\ A$, and the number of turns is n, and the radius of either coil is $'r'\ m$, then the resultant field at a point on the axis midway between the coils is (in T)
   (a) $\frac{8\mu_0 nI}{5\sqrt{5}r}$ (b) $\frac{4\mu_0 nI}{5\sqrt{5}r}$ (c) zero (d) either(a) or (c)

5. An infinite straight conductor carrying current $2I$ is split into a loop of radius r as shown in figure. The magnetic field at the centre of the coil is



   (a) $\frac{\mu_0}{4\pi}\frac{2(\pi+1)}{r}$ (b) $\frac{\mu_0}{4\pi}\frac{2(\pi-1)}{r}$
   (c) $\frac{\mu_0}{4\pi}\frac{(\pi+1)}{r}$ (d) zero

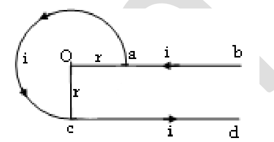
6. The wire loop $MNOPM$ is formed by connecting two semi-circular wires of radii r_1 and r_2 and two straight wires MN and OP as shown in the figure. The magnetic field at the centre C is (in T)



(a) $\frac{2\mu_0 I}{r_1 r_2}$ (b) $\frac{\mu_0 I}{2}\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$

(c) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$ (d) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$

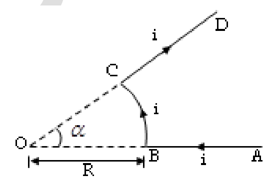
7. What is magnetic induction at point O, if the current carrying wire is in the shape given in fig?



(a) $\frac{\mu_0 i}{4\pi r}$ (b) $\frac{\mu_0 i}{4\pi r}\left(\frac{\pi}{2}+1\right)$

(c) $\frac{\mu_0 i}{4\pi r}.\frac{\pi}{2}$ (d) $\frac{\mu_0 i}{4\pi r}\left(\frac{3\pi}{2}+1\right)$

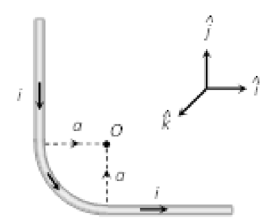
8. Two long straight wires are connected by a circular section which has radius R. All the three segments lie in same plane and carry a current i. The magnetic induction at centre O of the circular segment is



(a) $\frac{\mu_0 i}{4\pi R}$ (b) $\frac{\mu_0 i}{4\pi R}$

(c) $\frac{\alpha\mu_0 i}{R}$ (d) $\frac{\alpha\mu_0 i}{4\pi R}$

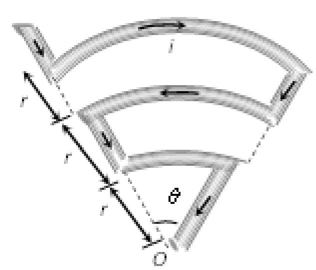
9. The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ are as shown below. What will be the magnetic field at O in the following figure



(a) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2-\frac{\pi}{2}\right)\hat{j}$ (b) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{j}$

(c) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{i}$ (d) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{k}$

10. Find magnetic field at O



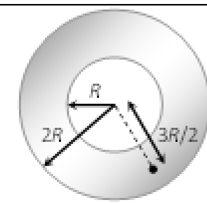
(a) $\frac{5\mu_0 i\theta}{24\pi r}$ (b) $\frac{\mu_0 i\theta}{24\pi r}$

(c) $\frac{11\mu_0 i\theta}{24\pi r}$ (d) Zero

ANSWER KEY

1. B	2. C	3. A	4. d	5. d	6. d	7. d	8. d	9. d	10. a

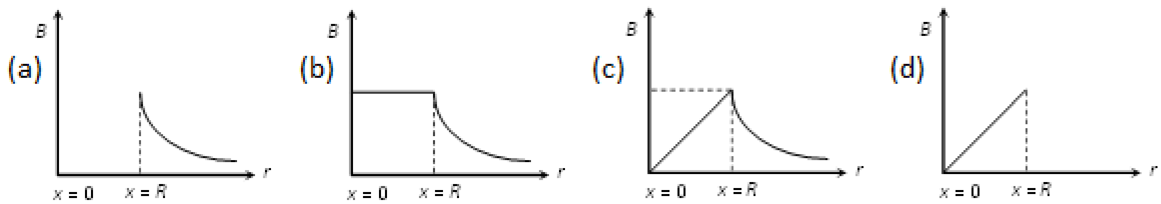
1. Figure shows the cross-sectional view of the hollow cylindrical conductor with inner radius 'R' and outer radius '2R', cylinder carrying uniformly distributed current along it's axis. The magnetic induction at point 'P' at a distance $\frac{3R}{2}$ from the axis of the cylinder will be



   (a) Zero (b) $\frac{5\mu_0 i}{72\pi R}$

   (c) $\frac{7\mu_0 i}{18\pi R}$ (d) $\frac{5\mu_0 i}{36\pi R}$

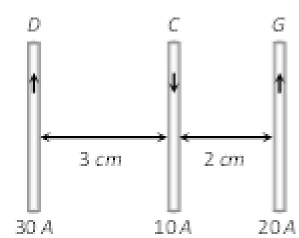
2. A long thin hollow metallic cylinder of radius 'R' has a current i ampere. The magnetic induction 'B'- away from the axis at a distance r from the axis varies as shown in



3. Two long conductors, separated by a distance d carry current I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its directions are reversed. The distance is also increased to 3d. The new value of the force between them is

   (a)– 2F (b) F/3 (c)2F/3 (d) – F/3

4. Three long, straight parallel wires carrying current are arranged as shown in figure. The force experienced by a 25 cm length of wire C is



   (a)10^{-3} N
   (b)2.5×10^{-3} N
   (c)Zero
   (d)1.5×10^{-3} N

5. A long wire A carries a current of 10 amp. Another long wire B, Which is parallel to A and separated by 0.1m from A, carries a current of 5 amp, in the opposite direction to that in A. what is the magnitude and nature of the force experienced per unit length of B

   $(\mu_0 = 4\pi \times 10^{-7}\ weber/amp\text{-}m)$

   (a) Repulsive force of $10^{-4}\ N/m$ (b) Attractive force of $10^{-4}\ N/m$
   (c) Repulsive force of $2\pi \times 10^{-5}\ N/m$ (d) Attractive force of $2\pi \times 10^{-5}\ N/m$

6. Two very long, straight and parallel wires carry steady currents I and I respectively. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires in the plane of the wires. Its instantaneous velocity v is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

(a) $\frac{\mu_0 Iqv}{2\pi d}$ (b) $\frac{\mu_0 Iqv}{\pi d}$ (c) $\frac{2\mu_0 Iqv}{\pi d}$ (d)0

7. Two circular coils A and B of radius $\frac{5}{\sqrt{2}}\ cm$ and 5 cm carry currents 5 A and $5\sqrt{2}$ A respectively the plane of B is perpendicular to plane of A and their centres coincide. Magnetic field at the centre is

(a) 0 (b) $4\pi\sqrt{2} \times 10^{-5} T$ (c) $4\pi\times 10^{-5} T$ (d) $2\pi\sqrt{2} \times 10^{-5} T$

8. A cylindrical long wire carries a current I uniformly distributed over the cross-sectional area of the wire. The magnetic field at a distance x from the surface inside the wire is

(a) $\frac{\mu_0 I}{2\pi(R-x)}$ (b) $\frac{\mu_0 I}{2\pi x}$ (c) $\frac{\mu_0 I}{2\pi(R+x)}$ (d) $\frac{\mu_0 I(R-x)}{2\pi R^2}$

9. The magnetic field at a distance x on the axis of a circular coil of radius R is $\frac{1}{8}th$ of that at the centre. The value of x is

(a) $\frac{R}{\sqrt{3}}$ (b) $\frac{2R}{\sqrt{3}}$ (c) $R\sqrt{3}$ (d) $R\sqrt{2}$

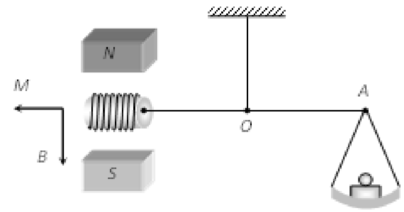
10. A horizontal wire carries 200A current below which another wire of linear density $20 \times 10^{-3}\ Kg/m$ carrying a current is kept at 2cm distance. If the wire kept below hangs in air, then the current in the wire is

(a) 9.8 A (b) 98 A (c) 980 A (d) 9800 A

ANSWER KEY

1. d	2. a	3. c	4. c	5. a	6. d	7. c	8. d	9. c	10. b

1. A small coil C with N = 200 turns is mounted on one end of a balance beam and introduced between the poles of an electromagnet as shown in figure. The cross sectional area of coil is A= 1.0 cm^2, length of arm OA of the balance beam is $l = 30\,cm$. When there is no current in the coil the balance is in equilibrium. On passing a current I = 22 mA through the coil the equilibrium is restored by putting the additional counter weight of mass $\Delta m = 60\ mg$ on the balance pan. Find the magnetic induction at the spot where coil is located.

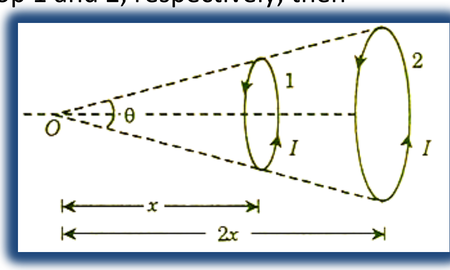


(a) 0.4 T (b) 0.3 T
(c) 0.2 T (d) 0.1 T

2. A tightly-wound long solenoid has n turns per unit length, radius r and carries a current i. A particle having charge q and mass m is projected from a point on the axis in the direction perpendicular to the axis. The maximum speed for which particle does not strike the solenoid will be
(a) $\frac{\mu_0 qrni}{2m}$ (b) $\frac{\mu_0 qrni}{m}$ (c) $\frac{2\mu_0 qrni}{3m}$ (d) none of these

3. A solid conducting sphere of radius R and total charge q rotates about its diametric axis with constant angular speed ω. The magnetic moment of the sphere is
(a) $\frac{1}{3}qR^2\omega$ (b) $\frac{2}{3}qR^2\omega$ (c) $\frac{1}{5}qR^2\omega$ (d) $\frac{2}{5}qR^2\omega$

4. The fig. Shows two coaxial circular loops 1 and 2, which forms same solid angle θ at the O. If B_1 and B_2 Are the magnetic fields produced at the point O due to loop 1 and 2, respectively, then



(a) $\frac{B_1}{B_2} = 1$ (b) $\frac{B_1}{B_2} = 2$
(c) $\frac{B_1}{B_2} = \frac{1}{2}$ (d) $\frac{B_1}{B_2} = 4$

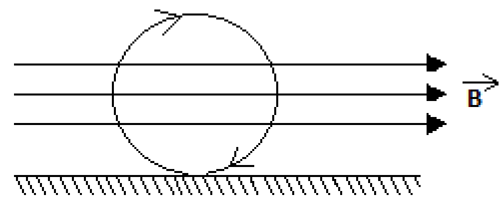
5. A non conducting disc of radius R, charge q is rotating about an axis passing through its center and perpendicular to its plane with an angular velocity ω charge q is uniformly distributed over its surface. The magnetic moment of the disc is
(a) $\frac{1}{4}q\omega R^2$ (b) $\frac{q\omega R}{2}$ (c) $q\omega R$ (d) $\frac{1}{2}q\omega R^2$

6. An insulating rod of length l carries a charge q uniformly distributed on it. The rod is pivoted at one of its ends and is rotated at a frequency f about a fixed perpendicular axis. The magnetic moment of the rod is
(a) $\frac{\pi q f l^2}{12}$ (b) $\frac{\pi q f l^2}{2}$ (c) $\frac{\pi q f l^2}{6}$ (d) $\frac{\pi q f l^2}{3}$

7. A galvanometer has a current range of 15 mA and voltage range of 750 mV. Find the shunt resistance required to convert this into a galvanometer of range 25 A

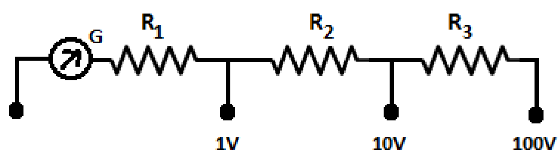
(a)0.03 Ω (b) 0.3 Ω (c) 3 Ω (d) 0.003 Ω

8. A Conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current I = 4A. A horizontal magnetic field B = 10 T is switched on at time t = 0 as shown in figure. The initial angular acceleration of the ring will be



(a) 40 π rad/s^2 (b) 20 π rad/s^2
(c) 5 π rad/s^2 (d) 15 π rad/s^2

9. A galvanometer has an internal resistance of 50Ω and current required for full scale deflection is 1 mA. Find the series resistances required as shown in fig. to use it as a voltmeter with different ranges, as indicated in fig.
(a) 950 $\Omega, 9k\Omega, 90k\Omega$
(b) 50$\Omega, 9\Omega, 90k\Omega$
(c) 1000 $\Omega, 9k\Omega, 90k\Omega$
(d) 450 $\Omega, 50k\Omega, 100k\Omega$



10. A galvanometer having a resistance of 50 Ω, given a full scale deflection for a current of 0.05A. The length in meter of a resistance wire of area of cross – section 2.97 $\times 10^{-2}$ cm^2 that can be used to convert the galvanometer into an ammeter which can read a maximum of 5 A current is (Specific resistance of the wire = 5 $\times$ 10^{-7} $\Omega - m$)
(a) 9 (b) 6 (c) 3 (d) 1.5

ANSWER KEY

1. a	2. a	3. c	4. b	5. a	6. d	7. a	8. a	9. a	10. c

1. Two short magnets with their axes horizontal and perpendicular to the magnetic meridian are placed with their centres 40 cm east and 50 cm west of magnetic needle. If the needle remains un deflected, the ratio of their magnetic moments $M_1 : M_2$ is

(a) 4 : 5 (b) 16 : 25 (c) 64 : 125 (d) $2:\sqrt{5}$

2. A bar magnet of length 10 cm and having the pole strength equal to 10^{-3} weber is kept in a magnetic field having magnetic induction (B) equal to $4\pi\times10^{-3}$ Tesla. It makes an angle of 30^o with the direction of magnetic induction. The value of the torque acting on the magnet is

(a) $2\pi\times10^{-7}\ N\times m$ (b) $2\pi\times10^{-5}\ N\times m$ (c) $0.5 N\times m$ (d) $0.5\times10^{2}\ N\times m$

($\mu_0 = 4\pi\times10^{-7}\ weber\ /\ amp\times m$)

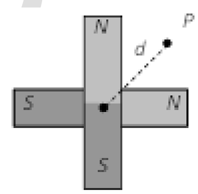
3. A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T ′, then ratio $\frac{T'}{T}$ is

(a) $\frac{1}{4}$ (b) $\frac{1}{2\sqrt{2}}$ (c) $\frac{1}{2}$ (d)2

4. Two short magnets of equal dipole moments M are fastened perpendicularly at their centre (figure). The magnitude of the magnetic field at a distance d from the centre on the bisector of the right angle is

(a) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$ (b) $\frac{\mu_0}{4\pi}\frac{M\sqrt{2}}{d^3}$

(c) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$ (d) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$



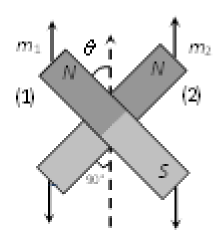
5. Two magnets of equal mass are joined at right angles to each other as shown the magnet 1 has a magnetic moment 3 times that of magnet 2. This arrangement is pivoted so that it is free to rotate in the horizontal plane. In equilibrium what angle will the magnet 1 subtend with the magnetic meridian

(a) $\tan^{-1}\left(\frac{1}{2}\right)$

(b) $\tan^{-1}\left(\frac{1}{3}\right)$

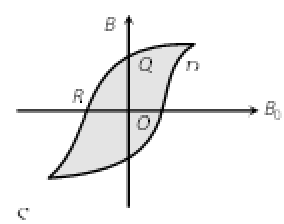
(c) $\tan^{-1}(1)$

(d)` 0°



6. The figure illustrate how B, the flux density inside a sample of unmagnetised ferromagnetic material varies with B_0, the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet

(a) OQ should be large, OR should be small
(b) OQ and OR should both be large
(c) OQ should be small and OR should be large
(d) OQ and OR should both be small



7. Each atom of an iron bar $(5\,cm \times 1\,cm \times 1\,cm)$ has a magnetic moment $1.8 \times 10^{-23}\ Am^2$. Knowing that the density of iron is $7.78 \times 10^3\ kg^{-3}m$, atomic weight is 56 and Avogadro's number is 6.02×10^{23} the magnetic moment of bar in the state of magnetic saturation will be

(a) $4.75\ Am^2$ (b) $5.74\ Am^2$ (c) $7.54\ Am^2$ * (d) $75.4\ Am^2$

8. A very small magnet is placed in the magnetic meridian with its south pole pointing north. The null point is obtained 20 cm away from the centre of the magnet. If the earth's magnetic field (horizontal component) at this point be 0.3 gauss, the magnetic moment of the magnet is

(a) $8.0 \times 10^2\, e.m.u.$ (b) $1.2 \times 10^3\, e.m.u.$ (c) $2.4 \times 10^3\, e.m.u.$ (d) $3.6 \times 10^3\, e.m.u.$

9. A current carrying coil is placed with its axis perpendicular to N-S direction. Let horizontal component of earth's magnetic field be H_o and magnetic field inside the loop is H. If a magnet is suspended inside the loop, it makes angle θ with H. Then θ =

(a) $\tan^{-1}\left(\frac{H_0}{H}\right)$ (b) $\tan^{-1}\left(\frac{H}{H_0}\right)$ (c) $\operatorname{cosec}^{-1}\left(\frac{H}{H_0}\right)$ (d) $\cot^{-1}\left(\frac{H_0}{H}\right)$

10. A bar magnet of moment M is cut into two equal pieces and they are arranged as shown in the figure. Find the resultant moment of the system.

(a) $\sqrt{\left(\frac{M}{2}\right)^2 + \left(\frac{M}{\pi}\right)^2}$ (b) M/2 (c) M (d) M / π

ANSWER KEY

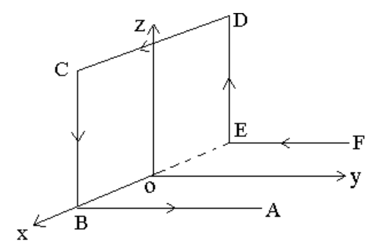
1. c	2. a	3. c	4. c	5. b	6. b	7. c	8. b	9. a	10. a

1. A electron experiences a force $(4.0\,\hat{\imath} + 3.0\,\hat{\jmath}) \times\ 10^{-13}\,N$ in a uniform magnetic field when its velocity is 2.5 $\hat{k}$ $X10^{7}\,ms^{-1}$. When the velocity is redirected and becomes$(1.5\,\hat{\imath} - 2.0\,\hat{\jmath}) \times 10^{7}\,ms^{-1}$, the magnetic force of the electron is zero. The magnetic field vector $\overrightarrow{B}$ is:
0.075$\hat{\imath} + 0.1\,\hat{\jmath}$ (b) 0.1$\hat{\imath} + 0.075\,\hat{\jmath}$ (c) 0.075$\hat{\imath} + 0.1\,\hat{\jmath} +\ \hat{k}$ (d) 0.075$\hat{\imath} - 0.1\,\hat{\jmath}$

2. A horizontal rod of mass 10 gm and length 10 cm is placed on a smooth plane inclined at an angle of 60° with the horizontal, with the length of the rod parallel to the edge of the inclined plane. A uniform magnetic field of induction B is applied vertically downwards. If the current through the rod is 1.73 ampere, then the value of B for which the rod remains stationary on the inclined plane is
(a)1.73 Tesla (b) $\frac{1}{1.73}$ Tesla (c) 1 Tesla (d)None of the above

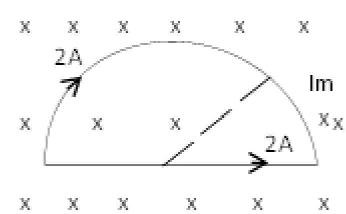
3. A particle of mass 1×10-26kg and charge +1.6×10-19 C travelling with a velocity of 1.28×106 m/s along positive direction of x-axis enters a region in which a uniform electric field $\vec{E}$ and a uniform magnetic field $\overrightarrow{B}$ are present such that $E_z = -\frac{102.4kV}{m}$ and $B_Y = 8 \times 10^{-2} Wb/m^2$
(a) The particle enters this region at origin at time t = 0. Then
(b) Net force acts on the particle along the +ev z-direction
(c) net force acting on particle is zero
(d) net force acts in x-z plane

4. A wire ABCDEF (with each side of length L) bent as shown in figure. and carrying a current I is placed in uniform magnetic field B parallel to the positive y-direction. What is the magnitude and direction of the force experienced by the wire?



(a) BIL along positive z-direction
(b) BI^2/L along positive z-direction
(c) BIL along negative z-direction
(d) BL/I along negative z-direction

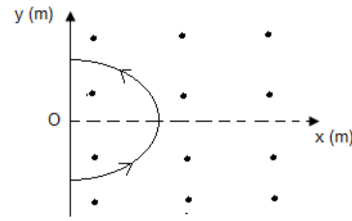
5. In the figure shown a semi-circular wire loop is placed in uniform field of 1 T. The plane of the loop is perpendicular to the field. The magnetic force on the loop is



(a) 2N (b) 4N
(c) 8N (d) zero

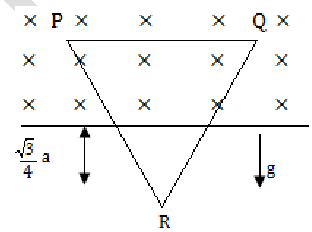
6. A wire of mass 100 g is carrying a current of 2A towards increasing x in the form of $y = x^2$ ($-2m \le x \le +2m$). This wire is placed in a magnetic field $\vec{B} = -0.02\hat{k}$ tesla. The acceleration of the wire (in m/s^2) is
(a) -1.6 $\hat{\jmath}$ (b) -3.2 $\hat{\jmath}$ (c) 1.6 $\hat{\jmath}$ (d) zero

7. A wire carrying a current of 3 A is bent in the form of a parabola $y^2 = 4 - x$ as shown in figure,
where x and y are in metre. The wire is placed in a uniform magnetic field $\vec{B} = 5\hat{k}$ tesla. The force acting on the wire is



(a) 60 $\hat{\imath}$ N
(b) -60 $\hat{\imath}$ N
(c) 30 $\hat{\imath}$ N
(d) -30 $\hat{\imath}$ N

8. An equilateral triangle frame PQR of mass M and side a is kept under the influence of magnetic force due to inward perpendicular magnetic field B and gravitational field as shown in fig. The magnitude and direction of current in the frame so that the frame remains at rest is



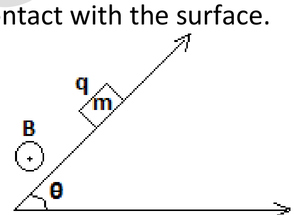
(a) I = $\frac{2Mg}{aB}, anticlockwise$ (b) I = $\frac{2Mg}{aB}, clockwise$

(c) I = $\frac{Mg}{aB}, anticlockwise$ (d) I = $\frac{Mg}{aB}, clockwise$

9. A block of mass m & charge q is released on a long smooth inclined plane magnetic field B is constant, uniform, as shown. Find the time from start when block loses contact with the surface.

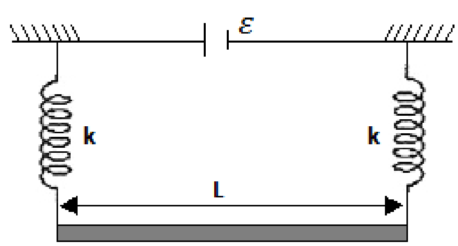
(a) $\frac{m\cos\theta}{qB}$ (b) $\frac{m\,coesec\,\theta}{qB}$

(c) $\frac{m\cot\theta}{qB}$ (d) none



10. A straight rod of mass m and length L is suspended from the identical spring as shown in the figure. The spring stretched by a distance of X_0 due to the weight of the wire. The circuit has total resistance RΩ. When the magnetic field perpendicular to the plane of the paper is switched on, springs are observed to extend further by the same distance. The magnetic field strength is

(a) $\frac{mgR}{\varepsilon L}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$
(b) $\frac{mgR}{2\varepsilon x_0}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$
(c) $\frac{mgR}{\varepsilon L}$; $directed\ into\ from\ the\ plane\ of\ the\ paper$
(d) $\frac{mgR}{\varepsilon L}$; $directed\ outward\ from\ the\ plane\ of\ the\ paper$



Answer Key

1. a	2. C	3. c	4. A	5. C	6. c	7. a	8. b	9. c	10. a

1. An electron is projected at an angle θ in a uniform magnetic field .if pitch of helical path is equal to the radius then the angle of projection θ is

(a) $\tan^{-1}\pi$ (b) $\tan^{-1}\pi$ (c) $\cot^{-1}\pi$ (d) $\cot^{-1} 2\pi$

2. A particle of specific charge $\frac{q}{m} = \pi x 10^{10} C/kg$ is projected from the origin along the positive x-axis with a velocity of 10^5 m/s in a uniform magnetic field $B = -2x10^{-3}\hat{k}$ tesla.

(a) The particle will move in the anticlockwise sense about the positive Z- axis
(b) The particle will move in the clockwise sense about the positive Z- axis
(c) The center of the circle lies on the y –axis
(d) The center of the circle on the x- axis

3. There ions H^{+}, He^{+} *and* O^{+2} having same kinetic energy pass through a region in which there is a uniform magnetic field perpendicular to their velocity, then:

(a) H^{+} *will be least deflected.* (b) He^{+} *and* O^{+2} *will be deflected equally.*
(c) O^{+2} *will be deflected most.* (d) all will be deflected equally.

4. A particle of charge per unit mass α is released from origin with velocity $\vec{v} = v_0\hat{i}$ in a magnetic field $\vec{B} = -B_0\hat{k}$ for $x \le \frac{\sqrt{3}}{2}\frac{v_o}{B_O\alpha}$, And $\vec{B} = 0$ for $x > \frac{\sqrt{3}}{2}\frac{v_o}{B_O\alpha}$ The x co-ordinate of the particle at time t $\left(> \frac{\pi}{3B_O\alpha}\right)$

(a) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + \frac{\sqrt{3}}{2}V_O\left(t - \frac{\pi}{B_O\alpha}\right)$ (b) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\left(t - \frac{\pi}{3B_O\alpha}\right)$

(c) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\frac{1}{2}\left(t - \frac{\pi}{3B_O\alpha}\right)$ (d) $\frac{\sqrt{3}}{2}\frac{V_O}{B_O\alpha} + V_O\frac{1}{2}$

5. When an electron is accelerated through a potential difference V, It experiences a force F through a uniform transverse magnetic field. If the potential difference is increased to 2V, the force experienced by the electron in the same magnetic field is

(a) 2F (b) $2\sqrt{2}F$ (c) $\sqrt{2}$ F (d) 4F

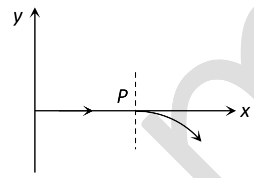
6. An ionized gas contains both positive and negative ions. If it is subjected simultaneously to an electric field along the +x direction and a magnetic field along the +z direction, then

(a) Positive ions deflect towards +y direction and negative ions towards –y direction
(b) All ions deflect towards +y direction
(c) All ions deflect towards –y direction
(d) Positive ions deflect towards –y direction and negative ions towards +y direction

7. A particle of mass m and charge q moves with a constant velocity v along the positive x direction. It enters a region containing a uniform magnetic field B directed along the negative z direction, extending from x = a to x = b. The minimum value of v required so that the particle can just enter the region $x > b$ is

(a) $qb\,B/m$ (b) $q(b-a)B/m$ (c) $qa\,B/m$ (d) $q(b+a)B/2m$

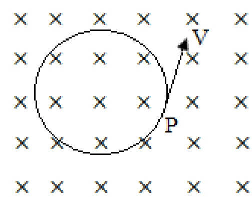
8. For a positively charged particle moving in a x-y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x-y plane and is found to be non-circular. Which one of the following combinations is possible



(a) $\vec{E}=0;\vec{B}=b\hat{i}+c\hat{k}$ (b) $\vec{E}=a\hat{i};\vec{B}=c\hat{k}+a\hat{i}$

(c) $\vec{E}=0;\vec{B}=c\hat{j}+b\hat{k}$ (d) $\vec{E}=a\hat{i};\vec{B}=c\hat{k}+b\hat{j}$

9. A particle having a charge of 20 µC and mass 20 µg moves along a circle of radius 5 cm under the action of a magnetic field B = 0. 1 tesla. When the particle is at P, uniform transverse electric field is switched on and it is found that the particle continues along the tangent with a uniform velocity. Find the electric field



(a) 2 V/m (b) 0.5 V/m (c) 5 V/m (d) 1.5 V/m

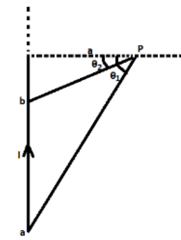
10. A particle of mass M and charge Q moving with velocity $\vec{v}$ describes a circular path of radius R when subjected to a uniform transverse magnetic field of induction B. The work done by the field when the particle completes one full circle is

(a) $BQv\,2\pi R$ (b) $\left(\frac{Mv^2}{R}\right)2\pi R$ (c) Zero (d) $BQ2\pi R$

ANSWER KEY

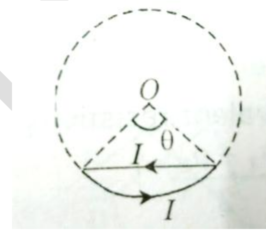
1. b	2. c	3. b	4. b	5. c
6. c	7. b	8. b	9. c	10. c

1. The straight wire ab carries a current I. The ends of the wire subtend angle θ_1 and θ_2 at the point P as shown in Fig. The magnetic field at the point P is
(angles are positive values)



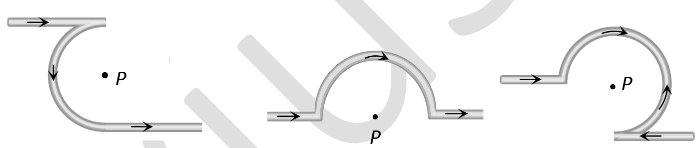
(a) $\frac{\mu_0 1}{4\pi a}\ (\sin\theta_1 - \sin\theta_2)$
(b) $\frac{\mu_0 1}{4\pi a}\ (\sin\theta_1 + \sin\theta_2)$
(c) $\frac{\mu_0 1}{4\pi a}\ (\sin\theta_1 - \cos\theta_2)$
(d) $\frac{\mu_0 1}{4\pi a}\ (\cos\theta_1 + \cos\theta_2)$

2. The fig. shows a small loop carrying a current I. the curved portion is an arc of circle of radius R and the straight portion is a chord to the same circle subtending an angle θ . The magnetic induction at the center O is



(a) Zero
(b) always inwards irrespective of the value of θ
(c) Inwards as long as θ is less than πα
(d) always outwards irrespective of the value of θ

3. The magnetic field at the centre of a circular coil of radius r is π times that due to a long straight wire at a distance r from it, for equal currents. Figure here shows three cases : in all cases the circular part has radius r and straight ones are infinitely long. For same current the B field at the centre P in cases 1, 2, 3 have the ratio



(1) (2) (3)

(a) $\left(-\frac{\pi}{2}\right):\left(\frac{\pi}{2}\right):\left(\frac{3\pi}{4}-\frac{1}{2}\right)$*

(b) $\left(-\frac{\pi}{2}+1\right):\left(\frac{\pi}{2}+1\right):\left(\frac{3\pi}{4}+\frac{1}{2}\right)$

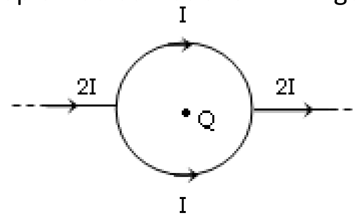
(c) $-\frac{\pi}{2}:\frac{\pi}{2}:3\frac{\pi}{4}$

(d) $\left(-\frac{\pi}{2}-1\right):\left(\frac{\pi}{2}-\frac{1}{4}\right):\left(\frac{3\pi}{4}+\frac{1}{2}\right)$

4. Two identical coils are placed co-axially so that the separation between their centres is equal to the radius of either of them. If the current in each coil is $'I'\ A$, and the number of turns is n , and the radius of either coil is $'r'\ m$, then the resultant field at a point on the axis midway between the coils is (in T)

(a) $\frac{8\mu_0 nI}{5\sqrt{5}r}$ (b) $\frac{4\mu_0 nI}{5\sqrt{5}r}$ (c) zero (d) either(a) or (c)

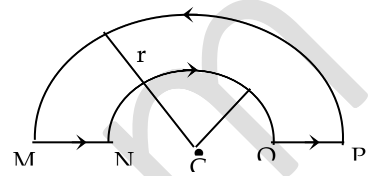
5. An infinite straight conductor carrying current $2I$ is split into a loop of radius r as shown in figure. The magnetic field at the centre of the coil is



(a) $\frac{\mu_0}{4\pi}\frac{2(\pi+1)}{r}$ (b) $\frac{\mu_0}{4\pi}\frac{2(\pi-1)}{r}$

(c) $\frac{\mu_0}{4\pi}\frac{(\pi+1)}{r}$ (d) zero

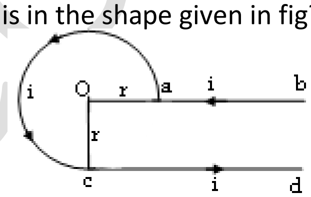
6. The wire loop $MNOPM$ is formed by connecting two semi-circular wires of radii r_1 and r_2 and two straight wires MN and OP as shown in the figure. The magnetic field at the centre C is (in T)



(a) $\frac{2\mu_0 I}{r_1 r_2}$ (b) $\frac{\mu_0 I}{2}\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$

(c) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$ (d) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$

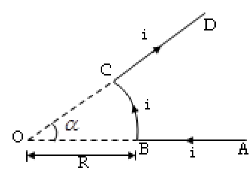
7. What is magnetic induction at point O, if the current carrying wire is in the shape given in fig?



(a) $\frac{\mu_0 i}{4\pi r}$ (b) $\frac{\mu_0 i}{4\pi r}\left(\frac{\pi}{2}+1\right)$

(c) $\frac{\mu_0 i}{4\pi r}.\frac{\pi}{2}$ (d) $\frac{\mu_0 i}{4\pi r}\left(\frac{3\pi}{2}+1\right)$

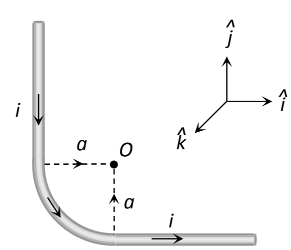
8. Two long straight wires are connected by a circular section which has radius R. All the three segments lie in same plane and carry a current i. The magnetic induction at centre O of the circular segment is



(a) $\frac{\mu_0 i}{4\pi R}$ (b) $\frac{\mu_0 i}{4\pi R}$

(c) $\frac{\alpha\mu_0 i}{R}$ (d) $\frac{\alpha\mu_0 i}{4\pi R}$

9. The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ are as shown below. What will be the magnetic field at O in the following figure



(a) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2-\frac{\pi}{2}\right)\hat{j}$ (b) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{j}$

(c) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{i}$ (d) $\frac{\mu_0}{4\pi}\frac{i}{a}\left(2+\frac{\pi}{2}\right)\hat{k}$ *

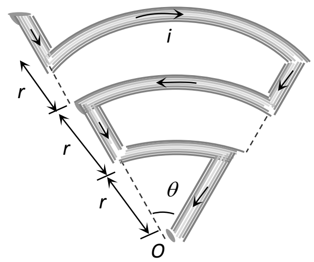
10. Find magnetic field at O

(a) $\frac{5\mu_0 i\theta}{24\pi r}$

(b) $\frac{\mu_0 i\theta}{24\pi r}$

(c) $\frac{11\mu_0 i\theta}{24\pi r}$

(d) Zero



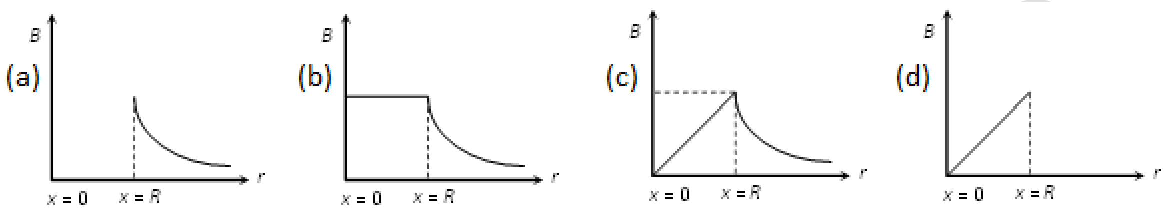
ANSWER KEY

1. a	2. c	3. a	4. d	5. d	6. d	7. d	8. d	9. d	10. a

1. Two long conductors, separated by a distance 'd' carry current I_1 *and* I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction in reversed.
The distance is also increased to 3d. The value of the force between them is

(a) $-2F$ (b) $\frac{F}{3}$ (c) $-\frac{2F}{3}$ (d) $-\frac{F}{3}$

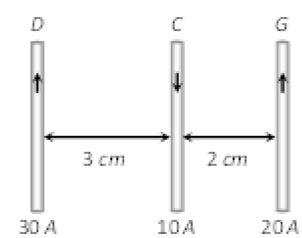
2. A long thin hollow metallic cylinder of radius 'R' has a current i ampere. The magnetic induction 'B'- away from the axis at a distance r from the axis varies as shown in



3. Two long conductors, separated by a distance d carry current I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its directions are reversed. The distance is also increased to 3d. The new value of the force between them is

(a)– 2F (b) F/3 (c)2F/3 (d) – F/3

4. Three long, straight parallel wires carrying current are arranged as shown in figure. The force experienced by a 25 cm length of wire C is



(a)10^{-3} N
(b)2.5×10^{-3} N
(c)Zero
(d)1.5×10^{-3} N

5. A long wire A carries a current of 10 amp. Another long wire B, Which is parallel to A and separated by 0.1m from A, carries a current of 5 amp, in the opposite direction to that in A. what is the magnitude and nature of the force experienced per unit length of B
$(\mu_0 = 4\pi \times 10^{-7}\ weber/amp\text{-}m)$

(a) Repulsive force of $10^{-4}\ N/m$ (b) Attractive force of $10^{-4}\ N/m$
(c) Repulsive force of $2\pi \times 10^{-5}\ N/m$ (d) Attractive force of $2\pi \times 10^{-5}\ N/m$

6. Two very long, straight and parallel wires carry steady currents I and I respectively. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires in the plane of the wires. Its instantaneous velocity v is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

(a) $\frac{\mu_0 Iqv}{2\pi d}$ (b) $\frac{\mu_0 Iqv}{\pi d}$ (c) $\frac{2\mu_0 Iqv}{\pi d}$ (d)0

7. Two circular coils A and B of radius $\frac{5}{\sqrt{2}}\ cm$ and 5 cm carry currents 5 A and $5\sqrt{2}$ A respectively the plane of B is perpendicular to plane of A and their centres coincide. Magnetic field at the centre is

(a) 0 (b) $4\pi\sqrt{2} \times 10^{-5}T$ (c) $4\pi\times 10^{-5}T$ (d) $2\pi\sqrt{2} \times 10^{-5}T$

8. A cylindrical long wire carries a current I uniformly distributed over the cross-sectional area of the wire. The magnetic field at a distance x from the surface inside the wire is

(a) $\frac{\mu_0 I}{2\pi(R-x)}$ (b) $\frac{\mu_0 I}{2\pi x}$ (c) $\frac{\mu_0 I}{2\pi(R+x)}$ (d) $\frac{\mu_0 I(R-x)}{2\pi R^2}$

9. The magnetic field at a distance x on the axis of a circular coil of radius R is $\frac{1}{8}th$ of that at the centre. The value of x is

(a) $\frac{R}{\sqrt{3}}$ (b) $\frac{2R}{\sqrt{3}}$ (c) $R\sqrt{3}$ (d) $R\sqrt{2}$

10. A horizontal wire carries 200A current below which another wire of linear density $20 \times 10^{-3}\ Kg/m$ carrying a current is kept at 2cm distance. If the wire kept below hangs in air, then the current in the wire is

(a) 9.8 A (b) 98 A (c) 980 A (d) 9800 A

ANSWER KEY

1. c	2. a	3. c	4. c	5. a	6. d	7. c	8. d	9. c	10. b

1. A coil carries a current and experience a torque due to a magnetic field. The value of the torque is 80% of the maximum possible torque. The angle between the magnetic field and the normal to the plane of the coil is

(a) 30^0 (b) 45^0 (c) 37^0 (d) 53^0

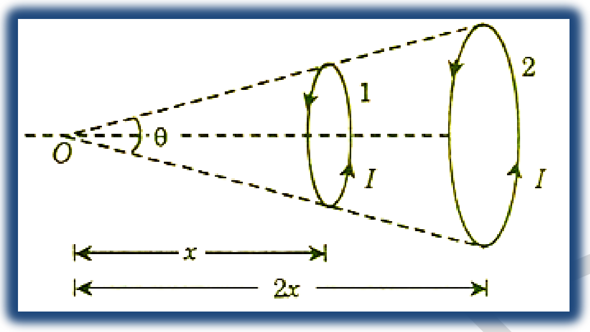
2. A tightly-wound long solenoid has n turns per unit length, radius r and carries a current i. A particle having charge q and mass m is projected from a point on the axis in the direction perpendicular to the axis. The maximum speed for which particle does not strike the solenoid will be

(a) $\frac{\mu_0 qrni}{2m}$ (b) $\frac{\mu_0 qrni}{m}$ (c) $\frac{2\mu_0 qrni}{3m}$ (d) none of these

3. A solid conducting sphere of radius R and total charge q rotates about its diametric axis with constant angular speed ω. The magnetic moment of the sphere is

(a) $\frac{1}{3}qR^2\omega$ (b) $\frac{2}{3}qR^2\omega$ (c) $\frac{1}{5}qR^2\omega$ (d) $\frac{2}{5}qR^2\omega$

4. The fig. Shows two coaxial circular loops 1 and 2, which forms same solid angle θ at the O. If B_1 and B_2 Are the magnetic fields produced at the point O due to loop 1 and 2, respectively, then



(a) $\frac{B_1}{B_2} = 1$ (b) $\frac{B_1}{B_2} = 2$ (c) $\frac{B_1}{B_2} = \frac{1}{2}$ (d) $\frac{B_1}{B_2} = 4$

5. A non conducting disc of radius R, charge q is rotating about an axis passing through its center and perpendicular to its plane with an angular velocity ω charge q is uniformly distributed over its surface. The magnetic moment of the disc is

(a) $\frac{1}{4}q\omega R^2$ (b) $\frac{q\omega R}{2}$ (c) $q\omega R$ (d) $\frac{1}{2}q\omega R^2$

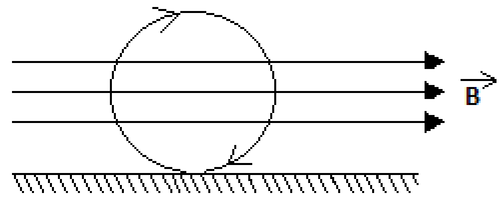
6. An insulating rod of length l carries a charge q uniformly distributed on it. The rod is pivoted at one of its ends and is rotated at a frequency f about a fixed perpendicular axis. The magnetic moment of the rod is

(a) $\frac{\pi q f l^2}{12}$ (b) $\frac{\pi q f l^2}{2}$ (c) $\frac{\pi q f l^2}{6}$ (d) $\frac{\pi q f l^2}{3}$

7. A galvanometer has a current range of 15 mA and voltage range of 750 mV. Find the shunt resistance required to convert this into a galvanometer of range 25 A

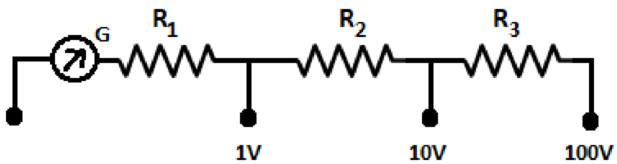
(a)0.03 Ω (b) 0.3 Ω (c) 3 Ω (d) 0.003 Ω

8. A Conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current I = 4A. A horizontal magnetic field B = 10 T is switched on at time t = 0 as shown in figure. The initial angular acceleration of the ring will be



(a) 40 π rad/s^2 (b) 20 π rad/s^2
(c) 5 π rad/s^2 (d) 15 π rad/s^2

9. A galvanometer has an internal resistance of 50Ω and current required for full scale deflection is 1 mA. Find the series resistances required as shown in fig. to use it as a voltmeter with different ranges, as indicated in fig.



(a) 950 Ω, 9kΩ, 90kΩ (b) 50Ω, 9Ω, 90kΩ
(c) 1000 Ω, 9kΩ, 90Kω (d) 450 Ω, 50kΩ, 100kΩ

10. A galvanometer having a resistance of 50 Ω, given a full scale deflection for a current of 0.05A. The length in meter of a resistance wire of area of cross – section $2.97 \times 10^{-2}\ \mathrm{cm}^2$ that can be used to convert the galvanometer into an ammeter which can read a maximum of 5 A current is (Specific resistance of the wire = $5 \times 10^{-7}\ \Omega - \mathrm{m}$)
(a) 9 (b) 6 (c) 3 (d) 1.5

ANSWER KEY

1. d	2. a	3. c	4. b	5. a	6. d	7. a	8. a	9. a	10. c

1. Two short magnets with their axes horizontal and perpendicular to the magnetic meridian are placed with their centres 40 cm east and 50 cm west of magnetic needle. If the needle remains un deflected, the ratio of their magnetic moments $M_1 : M_2$ is

(a) 4 : 5 (b) 16 : 25 (c) 64 : 125 (d) $2 : \sqrt{5}$

2. A bar magnet of length 10 cm and having the pole strength equal to 10^{-3} weber is kept in a magnetic field having magnetic induction (B) equal to $4\pi \times 10^{-3}$ Tesla. It makes an angle of 30^{o} with the direction of magnetic induction. The value of the torque acting on the magnet is

(a) $2\pi \times 10^{-7}\, N \times m$ (b) $2\pi \times 10^{-5}\, N \times m$ (c) $0.5 N \times m$ (d) $0.5 \times 10^{2}\, N \times m$

($\mu_0 = 4\pi \times 10^{-7}\, weber / amp \times m$)

3. A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T ′, then ratio $\frac{T'}{T}$ is

$\frac{1}{4}$ (b) $\frac{1}{2\sqrt{2}}$ (c) $\frac{1}{2}$ (d)2

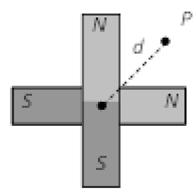
4. Two short magnets of equal dipole moments M are fastened perpendicularly at their centre (figure). The magnitude of the magnetic field at a distance d from the centre on the bisector of the right angle is

(a) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$

(b) $\frac{\mu_0}{4\pi}\frac{M\sqrt{2}}{d^3}$

(c) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$

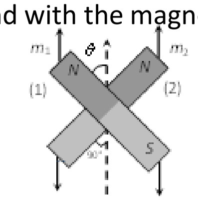
(d) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$



5. Two magnets of equal mass are joined at right angles to each other as shown the magnet 1 has a magnetic moment 3 times that of magnet 2. This arrangement is pivoted so that it is free to rotate in the horizontal plane. In equilibrium what angle will the magnet 1 subtend with the magnetic meridian

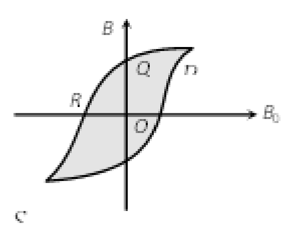
(a) $\tan^{-1}\left(\frac{1}{2}\right)$ (b) $\tan^{-1}\left(\frac{1}{3}\right)$

(c) $\tan^{-1}(1)$ (d) 0°



6. The figure illustrate how B, the flux density inside a sample of unmagnetised ferromagnetic material varies with B_0, the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet

(a) OQ should be large, OR should be small
(b) OQ and OR should both be large
(c) OQ should be small and OR should be large
(d) OQ and OR should both be small



7. Each atom of an iron bar $(5\,cm \times 1\,cm \times 1\,cm)$ has a magnetic moment $1.8 \times 10^{-23}\ Am^2$. Knowing that the density of iron is $7.78 \times 10^3\ kg^{-3}m,$ atomic weight is 56 and Avogadro's number is 6.02×10^{23} the magnetic moment of bar in the state of magnetic saturation will be

(a) $4.75\ Am^2$ (b) $5.74\ Am^2$ (c) $7.54\ Am^2$ (d) $75.4\ Am^2$

8. A very small magnet is placed in the magnetic meridian with its south pole pointing north. The null point is obtained 20 cm away from the centre of the magnet. If the earth's magnetic field (horizontal component) at this point be 0.3 gauss, the magnetic moment of the magnet is

(a) $8.0 \times 10^2\, e.m.u.$ (b) $1.2 \times 10^3\, e.m.u.$ (c) $2.4 \times 10^3\, e.m.u.$ (d) $3.6 \times 10^3\, e.m.u.$

9. A current carrying coil is placed with its axis perpendicular to N-S direction. Let horizontal component of earth's magnetic field be H_o and magnetic field inside the loop is H. If a magnet is suspended inside the loop, it makes angle θ with H. Then θ =

(a) $\tan^{-1}\left(\frac{H_0}{H}\right)$ (b) $\tan^{-1}\left(\frac{H}{H_0}\right)$ (c) $\operatorname{cosec}^{-1}\left(\frac{H}{H_0}\right)$ (d) $\cot^{-1}\left(\frac{H_0}{H}\right)$

10. A bar magnet of moment M is cut into two equal pieces and they are arranged as shown in the figure. Find the resultant moment of the system.

(a) $\sqrt{\left(\frac{M}{2}\right)^2 + \left(\frac{M}{\pi}\right)^2}$ (b) M/2 (c) M (d) M / π

ANSWER KEY

1. c	2. a	3. c	4. c	5. b	6. b	7. c	8. b	9. a	10. a

Optics

PHYSICS

1. An object is placed $5m$ from the plane mirror, then the object is moved towards the mirror with a velocity of 0.1 m/s. After 10 seconds the distance between the object and the image is

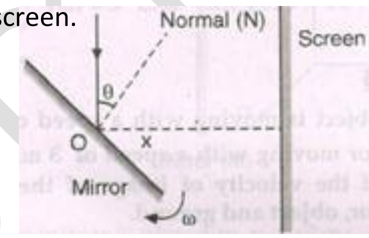
(a) $9m$ (b) $8m$ (c) $7m$ (d) $6m$

2. A man is standing exactly at midway between a wall and a mirror and he wants to see the full height of the wall (behind him) in a plane mirror (in front of him). The minimum length of mirror in this case should be: (Take H as the height of the wall)

(a)H/3 (b) H/2 (c) H (d) 2H

3. A plane mirror hinged at O is free to rotate in a vertical plane. The point O is at a distance x from a long screen placed in front of the mirror as shown in the figure. A laser beam of light incident vertically downward is reflected by the mirror at O so that a bright spot is formed at the screen.

At the instant shown, the angle of incidence is θ and the mirror is rotating clockwise with constant angular velocity ω. Find the speed of the spot at this instant.



(a) $x\omega\sec^2\phi$ (b) $2x\omega\cos^2\phi$

(c) $2x\omega\sec^2\phi$ (d) $x\omega\cos^2\phi$

4. O is a point object kept on bisector line between two mirrors inclined at 30^0 to each other. How many images can be observed?

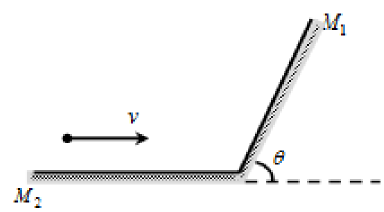
(a) 7 (b) 8 (c) 10 (d) 11

5. A ray of light is incident on the $(y-z)$ plane mirror along a unit vector, $\hat{e}_1 = \frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j} + \frac{1}{\sqrt{3}}\hat{k}$. Find the unit Vector $\hat{e}_2$ along the reflected ray.

(a) $\hat{e}_2 = \frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j} + \frac{1}{\sqrt{3}}\hat{k}$ (b) $\hat{e}_2 = -\frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j} + \frac{1}{\sqrt{3}}\hat{k}$

(c) $\hat{e}_2 = -\frac{1}{\sqrt{3}}\hat{i} - \frac{1}{\sqrt{3}}\hat{j} + \frac{1}{\sqrt{3}}\hat{k}$ (d) $\hat{e}_2 = -\frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j} - \frac{1}{\sqrt{3}}\hat{k}$

6. A point object is moving with a speed of v before an arrangement of two mirrors as shown in figure. Find the velocity of the image in mirror M_1, with respect to the image in mirror M_2.



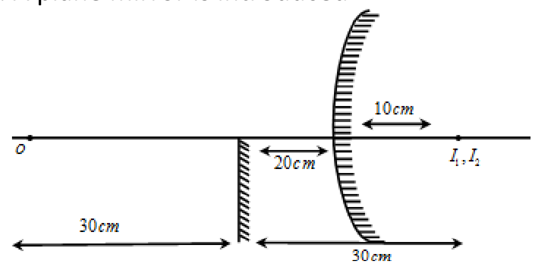
(a) $2v\cos\theta$ (b) $2v\sec\theta$

(c) $2v\tan\theta$ (d) $2v\sin\theta$

7. The focal length of a concave mirror is $30cm$. Find the position of the object in front of the mirror, so that the real image is three times the size of the object.

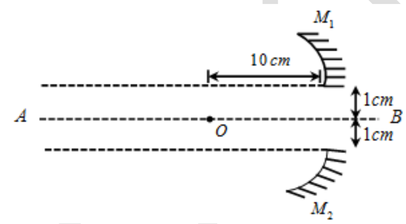
(a) 20 cm (b) 30 cm (c) 40 cm (d) 60 cm

8. An object is placed in front of a convex mirror at a distance of $50\ cm$. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and the plane mirror is $30\ cm$, it is found that there is no gap between the images formed by the two mirrors. What is the radius of curvature of the convex mirror?



(a) 20 cm (b) 25 cm
(c) 30 cm (d) 40 cm

9. A concave mirror of focal length $20cm$ is cut into two partsfrom the middle and these two parts are moved perpendicularly by a distance $1\ cm$ from the previous principal axis AB. Find the distance between the images formed by the two parts?



(a) 2 cm (b) 4cm
(c) 6 cm (d) 8 cm

10. A ball is kept at a height h above the surface of a heavy transparent sphere made of a material of refractive index μ . The radius of sphere is R. At t=0, the ball is dropped to fall normally on the sphere. Find the speed of the image formed as a function of time for $t < \sqrt{2h/g}$. Consider only the image by a single refraction.

(a) $\dfrac{\mu R^2 gt}{\left[(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

(b) $\dfrac{3\mu R^2 gt}{\left[(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

(c) $\dfrac{\mu R^2 gt}{\left[2(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

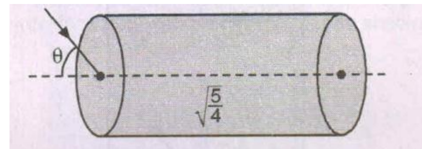
(d) None of these

ANSWER KEYS

1. b	2. a	3. c	4. d	5. b	6. d	7. c	8. b	9. a	10. a

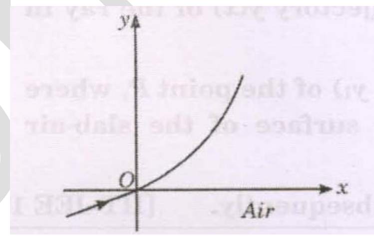
1. The refractive index of surrounding medium is 1 and that of silvered glass slab is $\mu_2 = 1.5$, thickness of slab $t = 6cm$. If the object is placed at 28cm from nearest surface of slab, find the final image position.
36 cm behind surface 1 (b) 20 cm behind surface 1
(c) 40 cm behind surface 2 (d) 20 cm behind surface 2

2. Light is incident making an angle θ with the axis of a transparent cylindrical fibre of refractive index $n = \sqrt{5/4}$ as shown in figure. Determine the maximum value of θ so that the light entering the cylinder does not come out of the curved surface.



(a) 60^0 (b) 30^0 (c) 90^0 (d) 45^0

3. The variation of refractive index assuming it to be a function of y such that a ray entering at origin at grazing incidence follows a parabolic path, $y = x^2$ as shown in figure is,

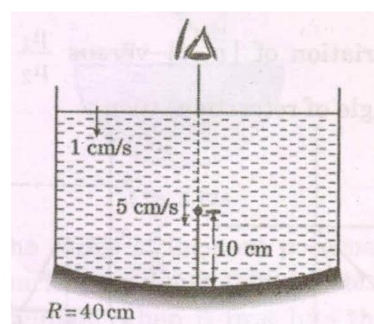


(a) $\mu = \sqrt{4y+1}$ (b) $\mu = \sqrt{2y+3}$

(c) $\mu = \sqrt{2y+1}$ (d) $\mu = \sqrt{4y+3}$

4. There is a dark spot just below a glass slab of refractive index 1.5 and of thickness 9 cm. A beaker of water of refractive index $4/3$ containing water of depth 12 cm is placed above the glass slab. When viewed vertically downwards, the dot appears to be at
(a) 10.5 cm (b) 15 cm (c) 18 cm (d) 21 cm

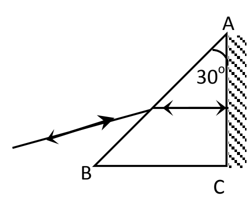
5. Water level in the tank is decreasing at a constant rate of 1 cm/s. A small metal sphere is moving downwards with a constant speed 5 cm/s. Base of the tank is a concave mirror of radius 40 cm. The velocity of the image as seen by the observer is:



(a) 2 cm/s (b) 3 cm/s

(c) 4 cm/s (d) None of these

6. A prism ABC of angle 30° has its face AC silvered. A ray of light incident at an angle of 45° at the face AB is found to retrace its path. The refractive index of the material of the prism is

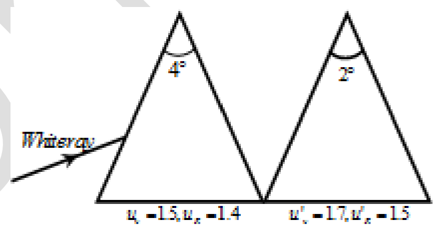


(a) 1.5 (b) $\sqrt{2}$
(c) $\sqrt{3}$ (d) $3/\sqrt{2}$

7. P is a point on the axis of a concave mirror. The image of P, formed by the mirror, coincides with P. A rectangular glass slab of thickness t and refractive index μ is now introduced between P and the mirror.
For the image of P to coincide with P again, the mirror must be moved
(a) towards P by $(\mu - 1)t$ (b) away from P by $(\mu - 1)t$
(c) towards P by $t(1 - 1/\mu)$ (d) away from P by $t(1 - 1/\mu)$

8. An equilateral prism deviates a ray through 23^0 for two angles of incidence differing by 23^0. Find the refractive index of the prism.
(a) $\frac{\sqrt{43}}{5}$ (b) $\frac{\sqrt{23}}{5}$ (c) $\frac{\sqrt{37}}{5}$ (d) $\frac{\sqrt{61}}{5}$

9. Two prisms are combined, as shown in figure. Find the total angular dispersion and angle of deviation suffered by a white ray of light incident on the combination.



(a) 0.7^0 , 4^0 (b) 0.8^0, 3^0
(c) 0.4^0, 5^0 (d) 0.5^0, 8^0

10. Refractive indices of glass for red and violet colours are 1.50 and 1.60 respectively for the medium of a glass prism. Find the dispersive power.
(a) 0.18 (b) 0.25 (c) 0.38 (d) 0.72

ANSWER KEYS

1. a	2. b	3. a	4. b	5. c	6. b	7. d	8. a	9. b	10. a

1. Light from a point source in air falls on a convex spherical glass surface of radius of curvature=20cm. The refractive index of glass =1.5. The distance of the light source from the glass surface is 100cm. At what distance from the surface is the image formed?

(a) 50 cm (b) 100 cm (c) 150 cm (d) 200 cm

2. A small object of height 0.5 cm is placed in air in front of a convex surface of glass $(\mu = 1.5)$ of radius of curvature 10 cm. Find the height of the image formed in glass.

(a) 1 cm (b) 2 cm (c) 3 cm (d) 4 cm

3. A ray of light is incident on a glass sphere of refractive index 3/2. The angle of incidence for which a ray that enters the sphere does not come out of the sphere is:

(a) $\tan^{-1}(2/3)$ (b) $\sin^{-1}(2/3)$ (c) 45^0 (d) 90^0

4. A ring of radius 1 cm is placed 1 m in front of a spherical glass ball of radius 25 cm with refractive index 1.50. Determine the magnification of the image of the ring formed by refraction at first surface.

(a) -1 (b) 2 (c) -3 (d) 4

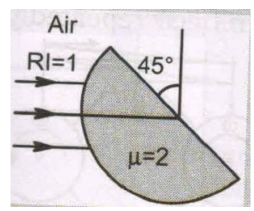
5. A parallel beam of light is incident on a transparent hemisphere of refractive index 2 as shown in figure. O is the centre. The radius of the hemisphere is R. From the situation described thus, choose the correct statement.

(a) the central ray of the beam suffers, total internal reflection at the plane surface of hemisphere.

(b) as we move up or down from central ray of beam, chances of total internal reflection at plane surface is more.

(c) as we move down from central ray of beam, chances of total internal reflection at plane surface is more.

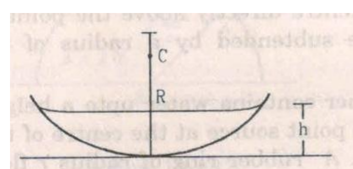
(d) none of the above.



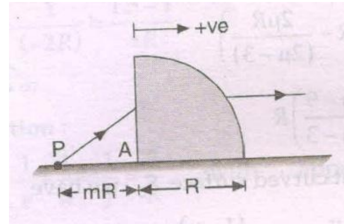
6. A concave mirror of radius R is kept on a horizontal surface as shown in figure. Water of refractive index μ is poured into it up to a height h. Where should an object be placed so that its image is formed on itself?

(a) $\left(\dfrac{R+h}{\mu}\right)$ above the water surface (b) $\left(\dfrac{R-h}{\mu}\right)$ above the water surface

(c) $\left(\dfrac{R}{\mu}\right)$ above the water surface (d) none of these



7. A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance ofmR from it. Find the value of m for which a ray from P will emerge parallel to the table as shown in figure.



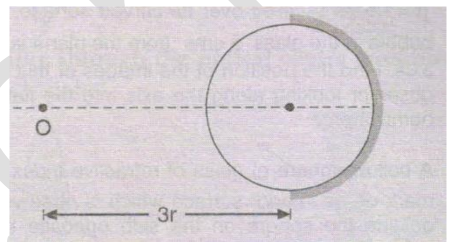
(a) 3 (b) 2

(c) 3/4 (d) 4/3

8. A spherical convex surface separates object and image space of refractive index 1 and 4/3. If radius of curvature of the surface is 10 cm, find its power.

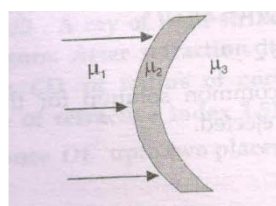
(a) 1.5 D (b) 2.5 D (c) 3.5 D (d) 4.5 D

9. A hemispherical portion of the surface of a solid glass sphere of refractive index 1.5 and of radius r is silvered to make the inner side reflecting. An object is placed at the axis of the sphere at a distance 3r from the centre of the sphere. The light from the object is refracted at the unsilvered part, then reflected from the silvered part and again refracted at the unsilvered part. Locate the final image formed.



(a) at the pole of the mirror
(b) at the object itself
(c) at a point 3r from pole of the mirror
(d) at 4r from the centre of the sphere.

10. In the figure, light is incident on a system as shown. The radius of curvature for both the surfaces is R.
Determine the focal length of this system.



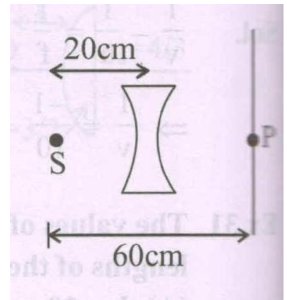
(a) $\dfrac{\mu_2 R}{\mu_2-\mu_1}$ (b) $\dfrac{\mu_2 R}{\mu_3-\mu_1}$

(c) $\dfrac{\mu_3 R}{\mu_3-\mu_1}$ (d) $\dfrac{\mu_1 R}{\mu_2-\mu_1}$

ANSWER KEYS

1. B	2. A	3. D	4. A	5. A	6. B	7.D	8. B	9. A	10. C

1. A point source of light is placed 60 cm away from screen. Intensity detected at point P is I. Now a diverging lens of focal length 20 cm is placed 20 cm away from S between S and P. The lens transmits 75% of light incident on it. Find the new value of intensity at P.



(a) 0.27 I (b) 0.36 I

(c) 0.45 I (d) 0.64 I

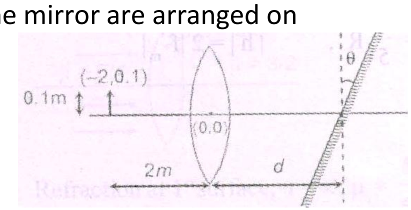
2. The power of an equiconvex lens made of material of refractive index 3/2 and having surfaces with radius of curvature 20 cm each is,

(a) 2D (b) 3D (c) 4D (d) 5D

3. The diverging lens has focal length 10 cm and a pencil is kept vertically at 15 cm in front of the lens. Choose the Correct option.

(a) A real, diminished image is formed at a distance of 6 cm.
(b) A virtual, enlarged image is formed at a distance of 6 cm.
(c) A virtual, diminished image is formed at a distance of 6 cm.
(d) A real, enlarged image is formed at a distance of 6 cm.

4. A convex lens of focal length 1.5 m is placed in a system of coordinate axis such that its optic centre is at the origin and principal axis coinciding with the X-axis. An object and a plane mirror are arranged on the principal axis as shown in the figure. Find the value of d (in m) so that y-coordinate of image (after refraction and reflection) is 0.3 m. (take $\tan\theta = 0.3$)



(a) 3 m (b) 4m
(c) 5m (d) none of these

5. A thin converging lens of focal length f is placed between an object and a screen fixed at a distance D apart. (Take D>4f). For the two positions of the lens at which a sharp image of the object is formed on the screen, the magnifications are related by the equation,

(a) $m_1 \times m_2 = 2$ (b) $m_1 \times m_2 = -1$ (c) $m_1 \times m_2 = 1$ (d) $m_1 \times m_2 = 1/2$

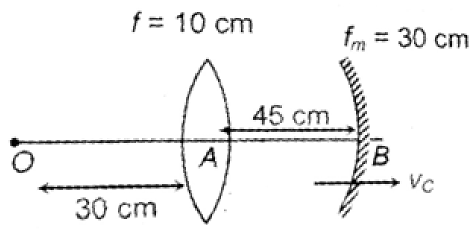
6. A point object is moving towards a biconvex lens of focal length 30 cm along the principal axis with a speed of $5ms^{-1}$. If the object is at 20 cm from the lens at the moment, what is the image velocity w.r.t. ground if lens is at rest always?

(a) $20\ ms^{-1}$ (b) $35\ ms^{-1}$ (c) $40\ ms^{-1}$ (d) $45\ ms^{-1}$

7. A biconvex thin lens is prepared from glass of refractive index 3/2. The two bounding surfaces have equal radii of 25 cm each. One of the surfaces is silvered from outside to make it reflecting. Where should an object be placed before this lens so that the image coincides with the object.

(a) 12.5 cm in front of silvered lens. (b) 25 cm in front of silvered lens.
(c) 50 cm in front of silvered lens. (d) 60 cm in front of silvered lens.

8. An object O is placed 30 cm left of a convex lens of focal length 10cm. A concave mirror starts moving towards right from point B and has a velocity, $v_c = \frac{(45-x)^2}{300}$ at any point on the axis. Here x is the separation between the lens and the mirror. The velocity of the image (with respect to ground) formed by the mirror is:



(a) $3+\frac{(45-x)^2}{300}$ (b) $4+\frac{(45-x)^2}{200}$

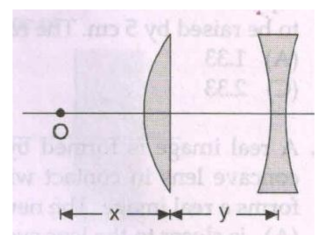
(c) $3+\frac{(45-x)^2}{200}$ (d) none of these

9. Two equi-convex lenses of focal lengths 30 cm and 70 cm, made of material of refractive index 1.5, are held in contact coaxially by a rubber band around their edges. A liquid of refractive index 1.3 is introduced in the space between the lenses filling it completely. Find the position of the image of a luminous point object placed on the axis of the combination lens at a distance of 90 cm from it.

(a) 20 cm (b) 25 cm (c) 40 cm (d) 45 cm

10. A plano convex glass lens $(\mu_g = 3/2)$ of radius of curvature R=10 cm is placed at a distance of y from a biconcave lens of focal length 20 cm. The distance x of a point object O from the plano convex lens so that the position of final image w.r.t. concave lens is independent of y is:

(a) 20 cm (b) 30 cm (c) 40 cm (d) 60 cm



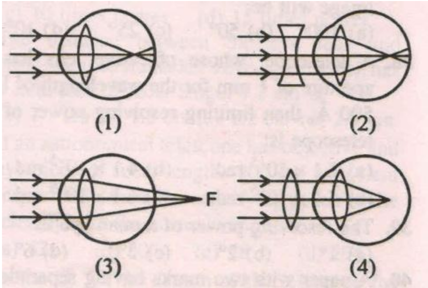
ANSWER KEYS

1. A	2. D	3. C	4. C	5. C	6. D	7.A	8. A	9. D	10. A

1. A person cannot see objects clearly beyond 50 cm. The power of the lens to correct the vision is:
(a) +5 dioptre (b) -0.5 dioptre (c) -2 dioptre (d) +2 dioptre

2. The resolution limit of the eye is 1 minute. At a distance x km from the eye, two persons stand with a lateral separation of 3 metre. For the two persons to be just resolved by the naked eye, x should be approximately,
(a) 10 km (b) 15 km (c) 20 km (d) 30 km

3. Identify the wrong description of the given figures,



(a) (1) represents far-sightedness

(b) (2) is the correction for short-sightedness

(c) (3) represents far-sightedness

(d) (4) is the correction for far-sightedness

4. The normal magnifying power of a simple microscope is 6. The focal length of the convex lens used is:
(a) 0.5 cm (b) 0.05 m (c) 5 m (d) 50 cm

5. If the ratio of magnifications produced by a simple microscope in near point adjustment and far point adjustment is 6/5, then the focal length of the lens is (take D=25 cm):
(a) 5 cm (b) 10 cm (c) 55 cm (d) 0.2 cm

6. The focal lengths of the objective and the eye-piece of a compound microscope are 1cm and 5 cm respectively. An object is placed at a distance of 1.1 cm from the objective. If the final image is formed at the least distance of distinct vision, the magnifying power is:
(a) 60 (b) 50 (c) 40 (d) none of these

7. In the previous question, what is the distance between the two lenses?
(a) 16 cm (b) 15.17 cm (c) 11 cm (d) 6 cm

8. A film projector magnifies a $100\ cm^2$ film strip on a screen. If the linear magnification is 4, the area of the magnified film on the screen is:
(a) $1600\ cm^2$ (b) $400\ cm^2$ (c) $800\ cm^2$ (d) $200\ cm^2$

9. The aperture of the largest telescope in the world is 5m. If the separation between the moon and earth is $4.5\times10^5\ km$ and the wavelength of visible light is 5000 Å, then the minimum separation between the objects on the surface of the moon which can be just resolved is approximately
(a) 1 m (b) 10 m (c) 50 m (d) 200 m

10. If F_1 and F_2 are focal lengths of objective and eye-piece respectively of the telescope, the angular magnification for the given telescope is equal to:

(a) $\frac{F_1}{F_2}$ (b) $\frac{F_2}{F_1}$ (c) $\frac{F_1 F_2}{F_1 + F_2}$ (d) $\frac{F_1 + F_2}{F_1 F_2}$

ANSWER KEYS

1. c	2. a	3. a	4. b	5. a	6. a	7.b	8. a	9. c	10. a

1. If two waves, each of intensity I_0, having the same frequency but differing by a constant phase angle of 60^0, superpose at a certain point in space, then the intensity of resultant wave is

(a) $2I_0$ (b) $\sqrt{3}I_0$ (c) $3I_0$ (d) $4I_0$

2. The maximum intensity on the screen in Young's double slit experiment is I_0. Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance D=10d?

(a) $\frac{I_0}{2}$ (b) $\frac{2I_0}{2}$ (c) I_0 (d) $\frac{I_0}{4}$

3. The light waves from two independent monochromatic light sources are given by:

$y_1 = 2\sin\omega t$, $y_2 = 3\cos\omega t$.

(a) Both waves are coherent (b) Both the waves are incoherent
(c) Both waves have different time periods (d) None of the above

4. In Young's double slit experiment, the angular width of a fringe formed on a distant screen is 1^0. The wavelength of light used is $6000\overset{0}{A}$. The spacing between the slits is approximately

(a) 1mm (b) 0.05 mm (c) 0.03 mm (d) 0.01 mm

5. In Young's experiment, when sodium light of wavelength $5893\overset{0}{A}$ is used, then 62 fringes are seen in the field of view. Instead, if violet light of wavelength $4358\overset{0}{A}$ is used then the number of fringes that will be seen in the field of view will be:

(a) 54 (b) 64 (c) 74 (d) 84

6. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude a and of wavelength λ and the resultant intensity at the centre of the screen is I_0. In another experiment with the same setup, one of the slits is closed. Now, the resultant intensity at the centre of the screen is:

(a) I_0 (b) $2\ I_0$ (c) $I_0/2$ (d) $I_0/4$

7. Intensity observed in an interference pattern is, $I = I_0\sin^2\theta$. At $\theta = 30^0$, intensity $I = 5 \pm 0.002$. The percentage error in angle, if $I_0 = 20\,\frac{W}{m^2}$ is:

(a) $4\sqrt{3} \times 10^{-2}$ % (b) $\frac{4}{\pi}\times10^{-2}$ % (c) $\frac{4\sqrt{3}}{\pi}\times10^{-2}$ % (d) $\sqrt{3}\times10^{-2}$ %

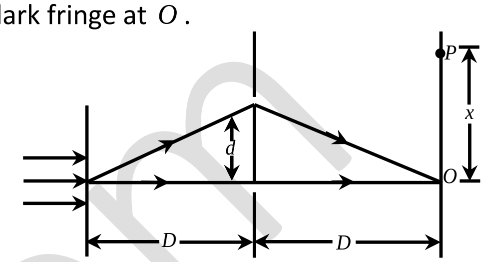
8. In YDSE, the y co-ordinates of central maximum and 10^{th} maxima are 2 cm and 5 cm respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5, the corresponding y co-ordinates will be:

(a) 2 cm, 7.5 cm (b) 3 cm, 6 cm (c) 2 cm, 4 cm (d) 4/3 cm, 10/3 cm

9. White light is used to illuminate the two slits in a Young's double slit experiment. The separation between the slits is b and the screen is at a distance d $(d \gg b)$ from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are:

(a) $\lambda = 3b^2/d$ (b) $\lambda = 2b^2/d$ (c) $\lambda = b^2/3d$ (d) $\lambda = 2b^2/3d$

10. Consider the arrangement shown in figure. The distance D is large compared to the separation d between the slits. Find the minimum value of d so that there is a dark fringe at O.



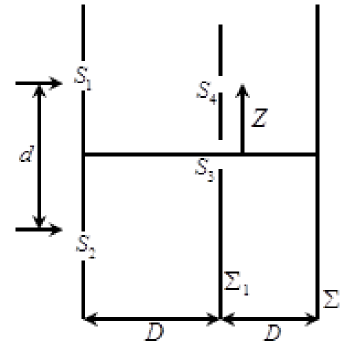
(a) $d = \sqrt{\frac{2D\lambda}{3}}$ (b) $d = \sqrt{\frac{4D\lambda}{3}}$

(c) $d = \sqrt{\frac{D\lambda}{3}}$ (d) $d = \sqrt{\frac{D\lambda}{2}}$

ANSWER KEYS

1. c	2. a	3. b	4. c	5. d	6. d	7.c	8. c	9. c	10. d

1. Consider the situation shown in the figure. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by a monochromatic light of wavelength λ. The separation between the slits is d. The light transmitted by the slits falls on a screen Σ_1 placed at a distance D from the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3. Another screen Σ_2 is placed a further distance D away from Σ_1. Find the ratio of the maximum to minimum intensity observed on Σ_2 if z is equal to $\frac{D\lambda}{2d}$



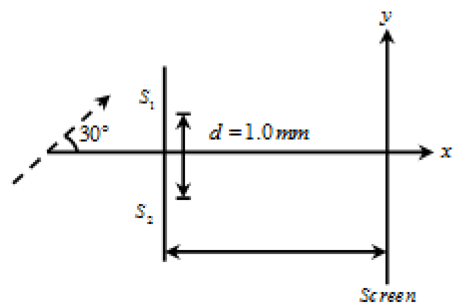
(a) 1:1 (b) 2:1

(c) 4:1 (d) 16:1

2. In a YDSE, find the thickness of a glass slab $(\mu = 1.5)$ which should be placed before the upper slit S_1 so that the central maximum now lies at a point where 5^{th} bright fringe was lying earlier (before inserting the slab). Wavelength of light used is $5000\,\mathring{A}$.

(a) $20000\,\overset{0}{A}$ (b) $30000\,\overset{0}{A}$ (c) $40000\,\overset{0}{A}$ (d) $50000\,\overset{0}{A}$

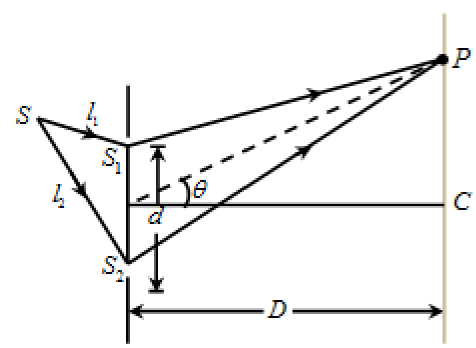
3. A coherent parallel beam of microwaves of wavelength $\lambda = 0.5\,mm$ falls on a young's double-slit apparatus. The separation between the slits is $1.0\,mm$. The intensity of microwaves is measured on a screen placed parallel to the plane of the slits at a distance of $1.0\,m$ from it as shown in figure. If the incident beam makes an angle of $30°$ with the $x-$ axis (as in the dotted arrow shown in the figure), find the $y-$coordinates of the first minimum on either side of the central maximum



(a) $y = \frac{3}{\sqrt{7}}m$ and $\frac{1}{\sqrt{15}}m$ (b) $y = \frac{2}{\sqrt{7}}m$ and $\frac{2}{\sqrt{15}}m$

(c) $y = \frac{1}{\sqrt{7}}m$ and $\frac{4}{\sqrt{15}}m$ (d) $y = \frac{2}{\sqrt{6}}m$ and $\frac{1}{\sqrt{12}}m$

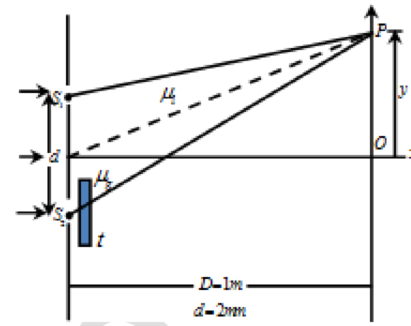
4. In a Young experiment, the light source is at a distance $l_1 = 20\,\mu m$ and $l_2 = 40\,\mu m$ from the slits. The light of wavelength $\lambda = 500\,nm$ is incident on slits separated by a distance $10\,\mu m$. A screen is placed at a distance $D = 2\,m$ away from the slits as shown in figure. How many maxima will appear on the screen (excluding the ones at infinity on either side)?



(a) 20 (b) 40

(c) 60 (d) 80

5. In a modified YDSEm, the region between screen and slits is immersed in a liquid whose refractive index varies with time as $\mu_l = \left(\frac{5}{2}\right) - \frac{T}{4}$ until it reaches a steady state value of $\frac{5}{4}$. A glass plate of thickness $36\mu m$ and refractive index $\frac{3}{2}$ is introduced in front of one of the slits. Find the time when it is at point O, located symmetrically on the $x-$axis.



(a) 2 s (b) 3 s

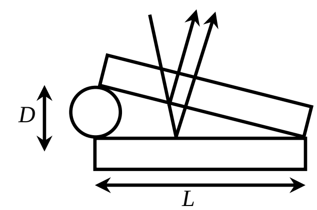
(c) 4 s (d) none of these

6. A beam of light consisting of two wavelengths $6500A^o$ and $5200A^o$ is used to obtain interference fringes in young's double slit experiment. Suppose the mthbright fringe due to $6500A^o$ coincides with the n^{th} bright fringe due to $5200A^o$ at a minimum distance from the central maximum then.

(a) m = 5, n = 4 (b) m = 4, n = 5

(c) m = 10, n = 8 (d) m = 8, n = 10

7. A wedge-shaped film of air is produced by placing a fine wire of diameter D between the ends of two flat glas plates of length $L = 20\ cm$, as shown in the fig. When the air film is illuminated with light of wavelength $\lambda = 550\ nm$, there are 12 dark fringes per centimetre. Find D



(a) $6.6\times10^{-5}\ cm$ (b) $8.8\times10^{-5}\ cm$

(c) $10\times10^{-5}\ cm$ (d) none of these

8. White light, with a uniform intensity across the visible wavelength range $430-690\,nm$, is perpendicularly incident on a water film, of index of refraction $\mu = 1.33$ and thickness $d = 320\ nm$, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer?

(a) 250 nm (b) 400 nm (c) 450 nm (d) 567 nm

9. Calculate the minimum thickness of a soap bubble film $(\mu = 1.33)$ that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is $\lambda = 600\ nm$.

(a) 56.1 nm (b) 91.2 nm (c) 112.78 nm (d) 211.2 nm

10. In a Biprism experiment with sodium light, bands of width $0.0195\ cm$ are observed at $100\ cm$ from slit. On introducing a convex lens $30\ cm$ away from the slit between biprism and screen, two images of the slit are seen $0.7\ cm$ apart at $100\ cm$ distance from the slit. Calculate the wavelength of sodium light.

(a) $4350\ \overset{0}{A}$ (b) $5850\,\overset{0}{A}$ (c) $6200\ \overset{0}{A}$ (d) none of these

ANSWER KEYS

1. a	2. d	3. a	4. b	5. c	6. b	7.a	8. d	9. c	10.b

1. The first diffraction minimum due to a single slit diffraction is at $\theta = 30^0$ for a light of wavelength $5000\overset{0}{A}$. The width of the slit is

(a) $5\times10^{-5}\ cm$ (b) $1.0\times10^{-4}\ cm$ (c) $2.5\times10^{-5}\ cm$ (d) $1.25\times10^{-5}\ cm$

2. Light of wavelength λ is incident on a slit of width d. The resulting diffraction pattern is observed on a screen at a distance D. The linear width of the principal maximum is then equal to the width of the slit if D equals:

(a) d/λ (b) $2\lambda/d$ (c) $d^2/2\lambda$ (d) $2\lambda^2/d$

3. Consider Fraunhoffer diffraction pattern obtained with a single slit illuminated at normal incidence. At the angular position of the first diffraction minimum, the phase difference (in radian) between the wavelets from the opposite edges of the slit is:

(a) π (b) 2π (c) $\pi/4$ (d) $\pi/2$

4. In a Fraunhoffer diffraction experiment at a single slit using light of wavelength 400 nm, the first minimum is formed at an angle of 30° . Then direction $'\theta'$ of first secondary maximum is given by

(a) $\sin^{-1}(3/4)$ (b) $\tan^{-1}(4/3)$ (c) 60° (d) $\tan^{-1}(3/4)$

5. The limit of resolution of a one metre radio telescope for radio waves of wave length 10 cm is about

(a) 7° (b) few seconds of arc (c) 18° (d) one minute of arc

6. A telescope has an aperture 140 cm. The least angular separation for two stars which can be resolved by the telescope for light of wavelength 5.6×10^{-7} m is

(a) 3.0×10^{-7} radian (b) 4.88×10^{-7} radian (c) 0.25×10^{-7} radian (d) 0.35×10^{-7} radian

7. Two wavelengths λ and $\lambda+\Delta\lambda$ (with $\Delta\lambda \ll \lambda$) are incident on a diffraction grating. Then, the angular separation between the spectral lines in the mth order spectrum is,

(a) $\Delta\theta = \dfrac{\Delta\lambda}{\sqrt{(d/m)^2-\lambda^2}}$ (b) $\Delta\theta = \dfrac{\Delta\lambda}{\sqrt{(m/d)^2-\lambda^2}}$

(c) $\Delta\theta = \dfrac{2\Delta\lambda}{\sqrt{(d/m)^2-\lambda^2}}$ (d) none of these

8. In a double slit experiment with wavelength of 500 nm, two slits are made one mm apart and the screen is placed one metre away. What should the width of each slit be to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern?

(a) 0.05 mm (b) 0.1 mm (c) 0.2 mm (d) 0.5 mm

9. What is the minimum distance between two points that will permit them to be resolved at 2km using a terrestrial telescope of 6.5×10^{-2}m diameter objective at wavelength of 5500 Å?

(a) 0.023 cm (b) 1.032 cm (c) 1.510 cm (d) 2.065 cm

10. Light of wave length 5893 Å is used in an experiment with a microscope. If the semi vertical angle is 50^0. Calculate the resolving power of the microscope.

(a) $2.6\times10^6 / m$ (b) $3.2\times10^6 / m$ (c) $4.3\times10^6 / m$ (d) $5.3\times10^6 / m$

ANSWER KEYS

1. b	2. c	3. b	4. a	5. a	6. b	7.a	8. c	9. d	10.a

1. The critical angle of certain medium is $\sin^{-1}\left(\frac{3}{5}\right)$. What is the polarizing angle of the medium?

(a) $\tan^{-1}(5/3)$ (b) $\tan^{-1}(3/5)$ (c) $\tan^{-1}(3/4)$ (d) $\tan^{-1}(4/3)$

2. If θ is the polarising angle for two optical media, whose critical angles are C_1 and C_2 , then the correct relation is:

(a) $\sin\theta = \frac{\sin C_2}{\sin C_1}$ (b) $\theta = \frac{\sin C_2}{\sin C_1}$ (c) $\tan\theta = \frac{\sin C_1}{\sin C_2}$ (d) $\sin\theta = \frac{\sin C_1}{\sin C_2}$

3. A Polaroid is being used as an analyzer of plane Polaroid light. In one complete rotation of the crystal, the maximum intensities will be observed only

(a) Once (b) twice (c) thrice (d) data is inadequate

4. When light is incident from air to glass at an angle 57^0 , the reflected beam is completely polarized. If the same beam is incident from water to glass, the angle of incidence at which reflected beam is completely polarized will be,

(a) $\theta = 57^0$ (b) $\theta > 57^0$ (c) $\theta < 57^0$ (d) cannot be determined

5. A beam of light strikes a piece of glass at an angle of incidence of 60^0 and the reflected beam is completely plane polarised. The refractive index of the glass is:

(a) 1.5 (b) $\sqrt{3}$ (c) $\sqrt{2}$ (d) $3/2$

6. A Polaroid is placed before an incoming light beam and allows intensity I_0 through itself. Now the intensity of light passing through the Polaroid after it is rotated by 45^0 would be:

(a) I_0 (b) $I_0/2$ (c) $I_0/4$ (d) zero

7. Two polaroids are kept crossed to each other. Now, one of them is rotated through an angle of 45^0 . The percentage of incident light now transmitted through the system is:

(a) 15% (b) 25% (c) 50% (d) 60%

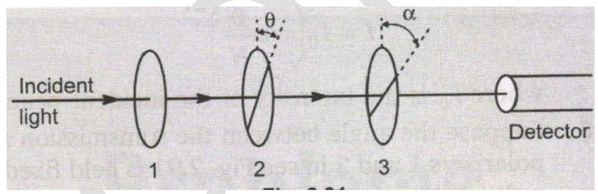
8. A clear sheet of Polaroid is placed on the top of similar sheet so that their axes make an angle $\sin^{-1}(3/5)$ with each other. The ratio of intensity of the emergent light to that of unpolarised incident light is:

(a) 16:25 (b) 9:25 (c) 4:5 (d) 8:25

9. Two polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second Polaroid. If a third Polaroid whose polarization axis makes an angle θ with the polarization axis of first Polaroid, is placed between these polaroids, then the intensity of light emerging from the last Polaroid will be

(a) $\frac{I_0}{8}\sin^2 2\theta$ (b) $\frac{I_0}{4}\sin^2 2\theta$ (c) $\frac{I_0}{2}\cos^4 \theta$ (d) $I_0 \cos^2 \theta$

10. Suppose that the transmission axes of the left and right polarizing discs are perpendicular to each other. Also, let the centre disc be rotated on the common axis with an angular speed ω. If unpolarized light is incident on the left disc with an intensity I_{max}, the intensity of the beam emerging from the right disc is,



(a) $I = \frac{I_{max}}{16}(1-\cos 2\omega t)$

(b) $I = \frac{I_{max}}{16}(1-\cos 4\omega t)$

(c) $I = \frac{I_{max}}{8}(1-\sin 2\omega t)$

(d) $I = \frac{I_{max}}{8}(1-\sin 4\omega t)$

ANSWER KEYS

1. A	2. C	3. B	4. C	5. B	6. A	7.B	8. D	9. A	10.B

1. A plane mirror makes an angle of 30^o with horizontal. If a vertical ray strikes the mirror, find the angle between mirror and reflected ray

(a) 30^o (b) 45^o (c) 60^o (d) 90^o

2. A ray of light makes an angle of 10^o with the horizontal above it and strikes a plane mirror which is inclined at an angle θ to the horizontal. The angle θ for which the reflected ray becomes vertical is

(a) 40^o (b) 50^o (c) 80^o (d) 100^o

3. A convex mirror of focal length f forms an image which is 1/n times the object. The distance of the object from the mirror is

(a) (n – 1) f (b) $\left(\frac{n-1}{n}\right)f$ (c) $\left(\frac{n+1}{n}\right)f$ (d) (n + 1) f

4. An object 5 cm tall is placed 1 m from a concave spherical mirror which has a radius of curvature of 20 cm. The size of the image is

(a) 0.11 cm (b) 0.40 cm (c) 0.55 cm (d) 0.70 cm

5. An object of length 2.5 cm is placed at a distance of 1.5 f from a concave mirror where f is the magnitude of the focal length of the mirror. The length of the object is perpendicular to the principle axis. The length of the image is

(a) 5 cm, erect (b) 10 cm, erect (c) 15 cm, erect (d) 5 cm, inverted

6. A square of side 3 cm is placed at a distance of 25 cm from a concave mirror of focal length 10 cm. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the wire is

(a) 4 cm^2 (b) 6 cm^2 (c) 16 cm^2 (d) 36 cm^2

7. A concave mirror of focal length 100 cm is used to obtain the image of the sun which subtends an angle of 30'. The diameter of the image of the sun will be

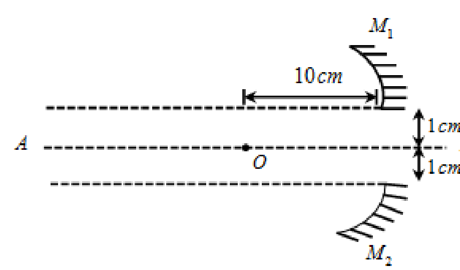
(a) 1.74 cm (b) 0.87 cm (c) 0.435 cm (d) 100 cm

8. A thin rod of length f / 3 lies along the axis of a concave mirror of focal length f. Nearest end of its magnified image touches an end of the rod. The length of the image is

(a) f (b) $\frac{1}{2}f$ (c) 2 f (d) $\frac{1}{4}f$

9. A concave mirror of focal length $20cm$ is cut into two parts from the middle and these two parts are moved perpendicularly by a distance $1\ cm$ from the previous principal axis AB. Find the distance between the images formed by the two parts?

(a) 2 cm (b) 4cm (c) 6 cm (d) 8 cm



10. A ball is kept at a height h above the surface of a heavy transparent sphere made of a material of refractive index μ . The radius of sphere is R. At t=0, the ball is dropped to fall normally on the sphere. Find the speed of the image formed as a function of time for $t<\sqrt{2h/g}$. Consider only the image by a single refraction.

(a) $\dfrac{\mu R^2 gt}{\left[(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

(b) $\dfrac{3\mu R^2 gt}{\left[(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

(c) $\dfrac{\mu R^2 gt}{\left[2(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$

(d) none of thes

ANSWER KEYS

1. c	2. a	3. a	4. c	5. d	6. a	7. b	8. b	9. a	10. a

1. A beam of monochromatic blue light of wavelength 4200 Å in air travels in water $(\mu = 4/3)$. Its wavelength in water will be

(a) 2800 Å (b) 5600 Å (c) 3150 Å (d) 4000 Å

2. On a glass plate a light wave is incident at an angle of 60°. If the reflected and the refracted waves are mutually perpendicular, the refractive index of material.

(a) $\frac{\sqrt{3}}{2}$ (b) $\sqrt{3}$ (c) $\frac{3}{2}$ (d) $\frac{1}{\sqrt{3}}$

3. Velocity of light in glass whose refractive index with respect to air is 1.5, is 2 × $10^8 m/s$ and in certain liquid the

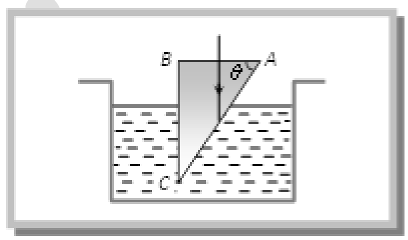
velocity of light found to be $2.50 \times 10^8 m/s$. The refractive index of the liquid with respect to air is

(a) 0.64 (b) 0.80 (c) 1.20 (d) 1.44

4. A rectangular slab of refractive index μ is placed over another slab of refractive index 3, both slabs being identical in dimensions. If a coin is placed below the lower slab, for what value of μwill the coin appear to be placed at the interface between the slabs when viewed from the top

(a) 1.8 (b) 2 (c) 1.5 (d) 2.5

5. A glass prism of refractive index 1.5 is immersed in water $(\mu = 4/3)$. A light beam incident normally on the face AB is totally reflected to reach the face BC if

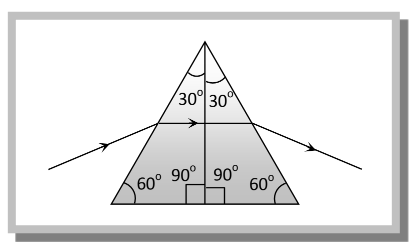


(a) $\sin\theta > 8/9$
(b) $2/3 < \sin\theta < 8/9$
(c) $\sin\theta \le 2/3$
(d) $\cos\theta \ge 8/9$

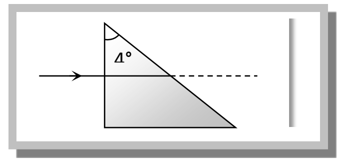
6. Two identical prisms 1 and 2, each with angles of 30°, 60° and 90° are placed in contact as shown in figure. A ray of light passed through the combination in the position of minimum deviation and suffers a deviation of 30°.

If the prism 2 is removed, then the angle of deviation of the same ray is

(a) Equal to 15° (b) equal to 30°
(c) equal to 60° (d) Equal to 90°



7. A prism having an apex angle 4^o and refraction index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror



(a) 176^o (b) 4^o (c) 178^o (d) 2^o

8. If the refractive indices of crown glass for red, yellow and violet colours are 1.5140, 1.5170 and 1.5318 respectively and for flint glass these are 1.6434, 1.6499 and 1.6852 respectively, then the dispersive powers forcrown and flint glass are respectively

(a) 0.034 and 0.064 (b) 0.064 and 0.034 (c) 1.00 and 0.064 (d) 0.034 and 1.0

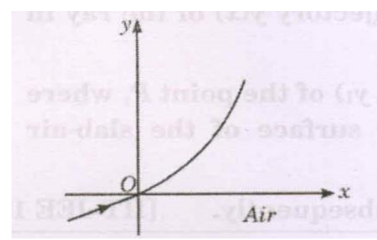
9. Flint glass prism is joined by a crown glass prism to produce dispersion without deviation. The refractive indices of these for mean rays are 1.602 and 1.500 respectively. Angle of prism of flint prism is 10^o, then the angle of prism for crown prism will be

(a) $12^o 2.4'$ (b) $12^o 62'$ (c) 1.24^o (d) 10^o

10. The variation of refractive index assuming it to be a function of y such that a ray entering at origin at grazing incidence follows a parabolic path, $y = x^2$ as shown in figure.

(a) $\mu = \sqrt{4y+1}$ (b) $\mu = \sqrt{2y+3}$

(c) $\mu = \sqrt{2y+1}$ (d) $\mu = \sqrt{4y+3}$



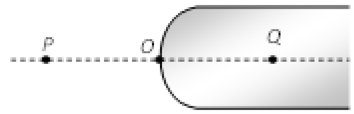
ANSWER KEYS

1. c	2. b	3. c	4. c	5. a	6. a	7. c	8. a	9. a	10. a

1. A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The line PQ cuts the surface at a point Oand $PO = OQ$. The distance PO is equal to

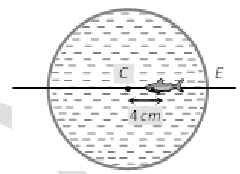
(a) 5 R (b) 3 R

(c)2 R (d) 1.5 R



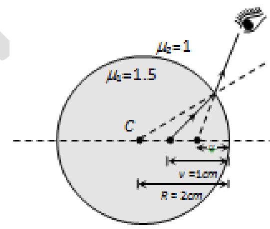
2. In a thin spherical fish bowl of radius 10 cm filled with water of refractive index 4/3 there is a small fish at a distance of 4 cm from the centre C as shown in figure. Where will the image of fish appear approximately, if seen from E

(a) 5.2 cm (b) 7.2 cm
(c) 4.2 cm (d) 3.2 cm



3. An air bubble in a glass sphere having 4 cm diameter appears 1 cm from surface nearest to eye when looked along diameter. If $_a\mu_g = 1.5$, the distance of bubble from refracting surface is

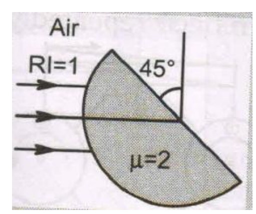
(a)1.2 cm (b) 3.2 cm
(c)2.8 cm (d)1.6 cm



4. A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β . The angle of deviation of the emergent ray from the direction of the incident ray is

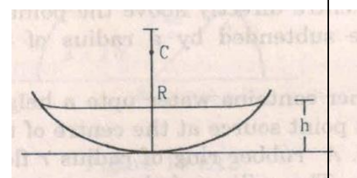
(a) $(\alpha - \beta)$ (b) $2(\alpha - \beta)$ (c) $(\alpha - \beta)/2$ (d) $(\alpha + \beta)$

5. A parallel beam of light is incident on a transparent hemisphere of refractive index 1 as shown in figure. O is the centre. The radius of the hemisphere is R. From the situation described thus, choose the correct statement.



(a) the central ray of the beam suffers, total internal reflection at the plane surface of hemisphere.
(b) as we move up or down from central ray of beam, chances of total internal reflection at plane surface is more.
(c) as we move down from central ray of beam, chances of total internal reflection at plane surface is more.
(d) none of the above.

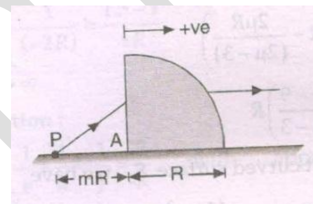
6. A concave mirror of radius R is kept on a horizontal surface as shown in figure. Water of refractive index μ is poured into it up to a height h. Where should an object be placed so that its image is formed on itself?



(a) $\left(\dfrac{R+h}{\mu}\right)$ above the water surface (b) $\left(\dfrac{R-h}{\mu}\right)$ above the water surface

(c) $\left(\dfrac{R}{\mu}\right)$ above the water surface (d) none of these

7. A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance of mR from it. Find the value of m for which a ray from P will emerge parallel to the table as shown in figure.



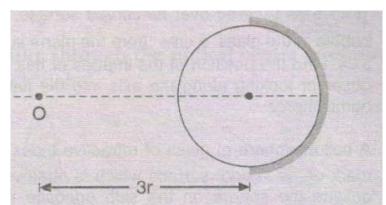
(a) 3 (b) 2

(c) 3/4 (d) 4/3

8. A spherical convex surface separates object and image space of refractive index 1 and 4/3. If radius of curvature of the surface is 10 cm, find its power.

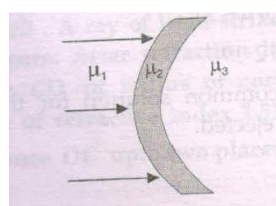
(a) 1.5 D (b) 2.5 D (c) 3.5 D (d) 4.5 D

9. A hemispherical portion of the surface of a solid glass sphere of refractive index 1.5 and of radius r is silvered to make the inner side reflecting. An object is placed at the axis of the sphere at a distance 3r from the centre of the sphere. The light from the object is refracted at the unsilvered part, then reflected from the silvered part and again refracted at the unsilvered part. Locate the final image formed.



(a) at the pole of the mirror
(b) at the object itself
(c) at a point 3r from pole of the mirror
(d) at 4r from the centre of the sphere.

10. In the figure, light is incident on a system as shown. The radius of curvature for both the surface is R. Determine the focal length of this system.



(a) $\dfrac{\mu_2 R}{\mu_2-\mu_1}$ (b) $\dfrac{\mu_2 R}{\mu_3-\mu_1}$

(c) $\dfrac{\mu_3 R}{\mu_3-\mu_1}$ (d) $\dfrac{\mu_1 R}{\mu_2-\mu_1}$

ANSWER KEYS

1. a	2. a	3. a	4. b	5. a	6. b	7. d	8. b	9.a	10. c

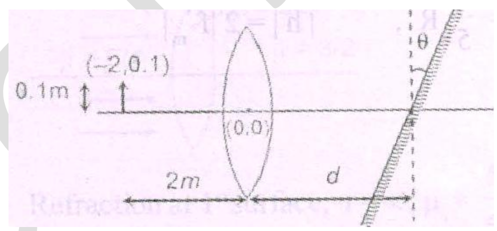
1. A thin lens has focal length f_1 and its aperture has diameter d. It forms an image of intensity I. Now the central part of the aperture upto diameter d/2 is blocked by an opaque paper. The focal length and image intensity will change to:

(a) $\frac{f}{2}$ and $\frac{I}{2}$ (b) f and $\frac{I}{4}$ (c) $\frac{3f}{4}$ and $\frac{I}{2}$ (d)f and $\frac{3I}{4}$

2. The power of a thin convex lens $({}_a\mu_g = 1.5)$ is + 5.0 D. When it is placed in a liquid of refractiveindex ${}_a\mu_l$, then it behaves as a concave lens of local length 100 cm. The refractive index of the liquid ${}_a\mu_l$ will be

(a) 5 / 3 (b) 4 / 3 (c) $\sqrt{3}$ (d) 5 / 4

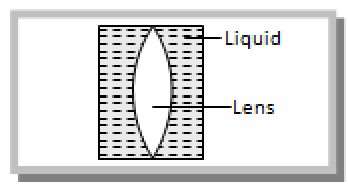
3. A convex lens of focal length 1.5 m is placed in a system of coordinate axis such that its optic centre is at the origin and principal axis coinciding with the X-axis. An object and a plane mirror are arranged on the principal axis as shown in the figure. Find the value of d (in m) so that y-coordinate of image (after refraction and reflection) is 0.3 m. (take $\tan\theta = 0.3$)



(a) 3 m (b) 4m

(c) 5m (d) none of these

4. Shown in figure here is a convergent lens placed inside a cellfilled with a liquid. The lens has focal length +20 cm when in air andits material has refractive index 1.50. If the liquid has refractive index 1.60, the focal length of the system is



(a)+ 80 cm (b) – 80 cm
(c)– 24 cm (d) – 100 cm

5. A point object is moving towards a biconvex lens of focal length 30 cm along the principal axis with a speed of $5ms^{-1}$. If the object is at 20 cm from the lens at the moment, what is the image velocity w.r.t. ground if lens is at rest always?

(a) $20\ ms^{-1}$ (b) $35\ ms^{-1}$ (c) $40\ ms^{-1}$ (d) $45\ ms^{-1}$

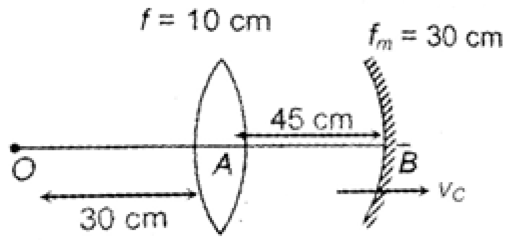
6. A thin converging lens of focal length f is placed between an object and a screen fixed at a distance D apart. (Take D>4f). For the two positions of the lens at which a sharp image of the object is formed on the screen, the magnifications are related by the relation,

(a) $m_1 \times m_2 = 2$ (b) $m_1 \times m_2 = -1$ (c) $m_1 \times m_2 = 1$ (d) $m_1 \times m_2 = 1/2$

7. A biconvex thin lens is prepared from glass of refractive index 3/2. The two bounding surfaces have equal radii of 25 cm each. One of the surfaces is silvered from outside to make it reflecting. Where an object should be placed before this lens so that the image coincides with the object.

(a) 12.5 cm in front of silvered lens. (b)25 cm in front of silvered lens.
(c) 50 cm in front of silvered lens. (d) 60 cm in front of silvered lens.

8. An object O is placed 30 cm left of a convex lens of focal length 10cm. A concave mirror starts moving towards right from point B and has a velocity, $v_c = \frac{(45-x)^2}{300}$ at any point on the axis. Here x is the separation between the lens and the mirror. The velocity of the image (with respect to ground) formed by the mirror is:



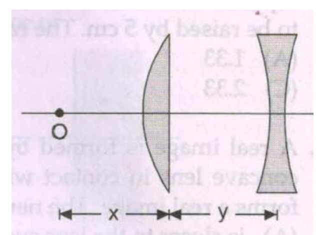
(a) $3+\frac{(45-x)^2}{300}$ (b) $4+\frac{(45-x)^2}{200}$

(c) $3+\frac{(45-x)^2}{200}$ (d) none of these

9. Two equi-convex lenses of focal lengths 30 cm and 70 cm, made of material of refractive index 1.5, are held in contact coaxially by a rubber band around their edges. A liquid of refractive index 1.3 is introduced in the space between the lenses filling it completely. Find the position of the image of a luminous point object placed on the axis of the combination lens at a distance of 90 cm from it.

(a) 20 cm (b) 25 cm (c) 40 cm (d) 45 cm

10. A plano convex glass lens $(\mu_g = 3/2)$ of radius of curvature R=10 cm is placed at a distance of y from a concave lens of focal length 20 cm. The distance x of a point object O from the plano convex lens so that the position of final image w.r.t. concave lens is independent of y is:



(a) 20 cm (b) 30 cm

(c) 40 cm (d) 60 cm

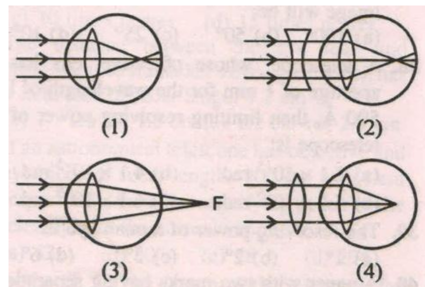
ANSWER KEYS

1. d	2. a	3. c	4. d	5. d	6. c	7. a	8. a	9.d	10. a

1. A person cannot see objects clearly beyond 50 cm. The power of the lens to correct the vision is:
(a) +5 dioptre (b) -0.5 dioptre (c) -2 dioptre (d) +2 dioptre

2. The resolution limit of the eye is 1 minute. At a distance x km from the eye, two persons stand with a lateral separation of 3 metre. For the two persons to be just resolved by the naked eye, x should be approximately,
(a) 10 km (b) 15 km (c) 20 km (d) 30 km

3. Identify the wrong description of the given figures,



(a) (1) represents far-sightedness

(b) (2) is the correction for short-sightedness

(c) (3) represents far-sightedness

(d) (4) is the correction for far-sightedness

4. The normal magnifying power of a simple microscope is 6. The focal length of the convex lens used is:
(a) 0.5 cm (b) 0.05 m (c) 5 m (d) 50 cm

5. If the ratio of magnifications produced by a simple microscope in near point adjustment and far point adjustment is 6/5, then the focal length of the lens is (take D=25 cm):
(a) 5 cm (b) 10 cm (c) 55 cm (d) 0.2 cm

6. The focal lengths of the objective and the eye-piece of a compound microscope are 1cm and 5 cm respectively. An object is placed at a distance of 1.1 cm from the objective. If the final image is formed at the least distance of distinct vision, the magnifying power is:
(a) 60 (b) 50 (c) 40 (d) none of these

7. In the previous question, what is the distance between the two lenses?
(a) 16 cm (b) 15.17 cm (c) 11 cm (d) 6 cm

8. A film projector magnifies a $100\ cm^2$ film strip on a screen. If the linear magnification is 4, the area of the magnified film on the screen is:
(a) $1600\ cm^2$ (b) $400\ cm^2$ (c) $800\ cm^2$ (d) $200\ cm^2$

9. The aperture of the largest telescope in the world is 5m. If the separation between the moon and earth is $4.5\times10^5\ km$ and the wavelength of visible light is $5000\ \overset{0}{A}$, then the minimum separation between the objects on the surface of the moon which can be just resolved is approximately
(a) 1 m (b) 10 m (c) 50 m (d) 200 m

10. If F_1 and F_2 are focal lengths of objective and eye-piece respectively of the telescope, the angular magnification for the given telescope is equal to:

(a) $\frac{F_1}{F_2}$ (b) $\frac{F_2}{F_1}$ (c) $\frac{F_1F_2}{F_1+F_2}$ (d) $\frac{F_1+F_2}{F_1F_2}$

ANSWER KEYS

1. c	2. a	3. a	4. b	5. a	6. a	7. b	8. a	9.c	10. a

1. If two light waves having same frequency have intensity ratio 4: 1 and they interfere, the ratio of maximum to minimum intensity in the pattern will be

(a)9 : 1 (b) 3 : 1 (c) 25 : 9 (d) 16 : 25

2. The maximum intensity on the screen in Young's double slit experiment is I_0 . Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance D=10d?

(a) $\frac{I_0}{2}$ (b) $\frac{3I_0}{4}$ (c) I_0 (d) $\frac{I_0}{4}$

3. In a Young's double slit experiment, the slit separation is 1 mm and the screen is 1 m from the slit. For a monochromatic light of wavelength 500 nm, the distance of 3rd minima from the central maxima is

(a)0.50 mm (b) 1.25 mm (c) 1.50 mm (d) 1.75 mm

4. In Young's double slit experiment, the angular width of a fringe formed on a distant screen is 1^0 .

The wavelength of light used is $6000\overset{0}{A}$. The spacing between the slits is approximately

(a)1mm (b) 0.05 mm (c) 0.03 mm (d) 0.01 mm

5. In Young's experiment, when sodium light of wavelength 5893 Å is used, then 62 fringes are seen in the field of view. Instead, if violet light of wavelength 4358 Å is used then the number of fringes that will be seen in the field of view will be:

(a)54 (b) 64 (d) 74 (d) 84

6. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude a and of wavelength λ and the resultant intensity at the centre of the screen is I_0. In another experiment with the same setup, one of the slits is closed. Now, the resultant intensity at the centre of the screen is:

(a) I_0 (b) $2I_0$ (c) $I_0/2$ (d) $I_0/4$

7. Intensity observed in an interference pattern is , $I = I_0 \sin^2\theta$. At $\theta = 30^0$, intensity $I = 5 \pm 0.002$.

The percentage error in angle, if $I_0 = 20\ \frac{W}{m^2}$ is:

(a) $4\sqrt{3}\times10^{-2}$ % (b) $\frac{4}{\pi}\times10^{-2}$ %

(c) $\frac{4\sqrt{3}}{\pi}\times10^{-2}$ % (d) $\sqrt{3}\times10^{-2}$ %

8. In YDSE, the y co-ordinates of central maximum and 10^{th} maxima are 2 cm and 5 cm respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5, the corresponding y co-ordinates will be:

(a) 2 cm, 7.5 cm (b) 3 cm, 6 cm (c) 2 cm, 4 cm (d) 4/3 cm, 10/3 cm

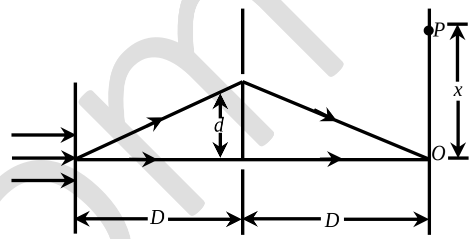
9. White light is used to illuminate the two slits in a Young's double slit experiment. The separation between the slits is b and the screen is at a distance d $(d \gg b)$ from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are:

(a) $\lambda = 3b^2 / d$ (b) $\lambda = 2b^2 / d$ (c) $\lambda = b^2 / 3d$ (d) $\lambda = 2b^2 / 3d$

10. Consider the arrangement shown in figure. The distance D is large compared to the separation d between the slits. Find the minimum value of d so that there is a dark fringe at O.

(a) $d = \sqrt{\frac{2D\lambda}{3}}$ (b) $d = \sqrt{\frac{4D\lambda}{3}}$

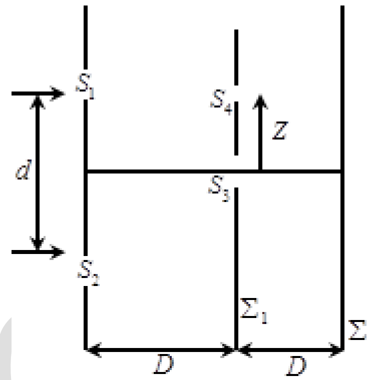
(c) $d = \sqrt{\frac{D\lambda}{3}}$ (d) $d = \sqrt{\frac{D\lambda}{2}}$



ANSWER KEYS

1. a	2. a	3. b	4. c	5. d	6. d	7. c	8. c	9.c	10. d

1. Consider the situation shown in the figure. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by a monochromatic light of wavelength λ. The separation between the slits is d. The light transmitted by the slits falls on a screen Σ_1 placed at a distance D from the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3. Another screen Σ_2 is placed a further distance D away from Σ_1. Find the ratio of the maximum to minimum intensity observed on Σ_2 if z is equal to $\frac{D\lambda}{2d}$



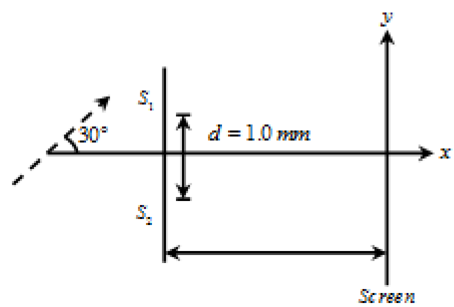
(a) 1:1 (b) 2:1

(c) 4:1 (d) 16:1

2. In a YDSE, find the thickness of a glass slab $(\mu = 1.5)$ which should be placed before the upper slit S_1 so that the central maximum now lies at a point where 5^{th} bright fringe was lying earlier (before inserting the slab). Wavelength of light used is $5000\,\overset{\circ}{A}$.

(a) $20000\ \overset{0}{A}$ (b) $30000\,\overset{0}{A}$ (c) $40000\ \overset{0}{A}$ (d) $50000\ \overset{0}{A}$

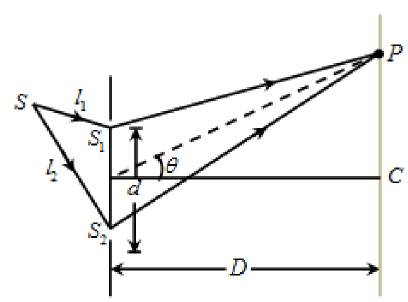
3. A coherent parallel beam of microwaves of wavelength $\lambda = 0.5\,mm$ falls on a young's double-slit apparatus. The separation between the slits is $1.0\,mm$. The intensity of microwaves is measured on a screen placed parallel to the plane of the slits at a distance of $1.0\,m$ from it as shown in figure. If the incident beam makes an angle of 30° with the $x-$ axis (as in the dotted arrow shown in the figure), find the $y-$coordinates of the first minimum on either side of the central maximum.



(a) $y = \frac{3}{\sqrt{7}}m$ and $\frac{1}{\sqrt{15}}m$ (b) $y = \frac{2}{\sqrt{7}}m$ and $\frac{2}{\sqrt{15}}m$

(c) $y = \frac{1}{\sqrt{7}}m$ and $\frac{4}{\sqrt{15}}m$ (d) $y = \frac{2}{\sqrt{6}}m$ and $\frac{1}{\sqrt{12}}m$

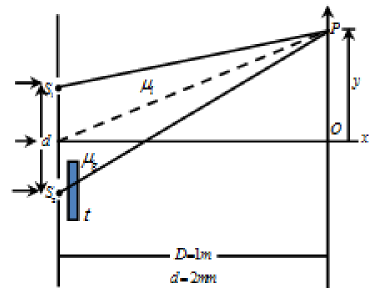
4. In a Young experiment, the light source is at a distance $l_1 = 20\,\mu m$ and $l_2 = 40\,\mu m$ from the slits. The light of wavelength $\lambda = 500\ nm$ is incident on slits separated by a distance $10\ \mu m$. A screen is placed at a distance $D = 2\ m$ away from the slits as shown in figure. How many maxima will appear on the screen (excluding the ones at infinity on either side)?



(a) 20 (b) 40

(c) 60 (d) 80

5. In a modified YDSE, the region between screen and slits is immersed in a liquid whose refractive index varies with time as $\mu_l = \left(\frac{5}{2}\right) - \frac{T}{4}$ until it reaches a steady state value of $\frac{5}{4}$. A glass plate of thickness $36\mu m$ and refractive index $\frac{3}{2}$ is introduced in front of one of the slits. Find the time when it is at point O, located symmetrically on the $x-$axis.



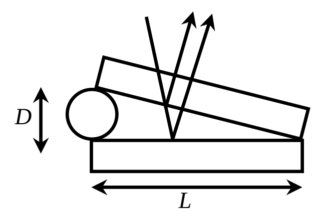
(a) 2 s (b) 3 s

(b) (c) 4 s (d) none of these

6. A beam of light consisting of two wavelengths $6500A^o$ and $5200A^o$ is used to obtain interference fringes in young's double slit experiment. Suppose the mth bright fringe due to $6500A^o$ coincides with the n^{th} bright fringe due to $5200A^o$ at a minimum distance from the central maximum then.

(a) m = 5, n = 4 (b) m = 4, n = 5
(c) m = 10, n = 8 (d) m = 8, n = 10

7. A wedge-shaped film of air is produced by placing a fine wire of diameter D between the ends of two flat glass plates of length $L = 20\ cm$, as shown in the fig. When the air film is illuminated with light of wavelength $\lambda = 550\ nm$, there are 12 dark fringes per centimetre. Find D



(a) $6.6\times10^{-5}\ cm$ (b) $8.8\times10^{-5}\ cm$

(c) $10\times10^{-5}\ cm$ (d) none of these

8. White light, with a uniform intensity across the visible wavelength range $430-690\,nm$, is perpendicularly incident on a water film, of index of refraction $\mu = 1.33$ and thickness $d = 320\ nm$, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer?

(a) 250 nm (b) 400 nm (c) 450 nm (d) 567 nm

9. Calculate the minimum thickness of a soap bubble film $(\mu = 1.33)$ that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is $\lambda = 600\ nm$.

(a) 56.1 nm (b) 91.2 nm (c) 112.78 nm (d) 211.2 nm

10. In a Biprism experiment with sodium light, bands of width $0.0195\ cm$ are observed at $100\ cm$ from slit. On introducing a convex lens $30\ cm$ away from the slit between biprism and screen, two images of the slit are seen $0.7\ cm$ apart at $100\ cm$ distance from the slit. Calculate the wavelength of sodium light.

(a) $4350\ \overset{0}{A}$ (b) $5850\,\overset{0}{A}$ (c) $6200\ \overset{0}{A}$ (d) none of these

ANSWER KEYS

1. a	2. d	3. a	4. b	5. c	6. b	7. a	8. d	9.c	10. b

1. The first diffraction minimum due to a single slit diffraction is at $\theta = 30^0$ for a light of wavelength $5000\overset{0}{A}$. The width of the slit is

(a) $5\times10^{-5}\ cm$ (b) $1.0\times10^{-4}\ cm$ (c) $2.5\times10^{-5}\ cm$ (d) $1.25\times10^{-5}\ cm$

2. Light of wavelength λ is incident on a slit of width d. The resulting diffraction pattern is observed on a screen at a distance D. The linear width of the principal maximum is then equal to the width of the slit if D equals:

(a) d/λ (b) $2\lambda/d$ (c) $d^2/2\lambda$ (d) $2\lambda^2/d$

3. Consider Fraunhoffer diffraction pattern obtained with a single slit illuminated at normal incidence. At the angular position of the first diffraction minimum, the phase difference (in radian) between the wavelets from the opposite edges of the slit is:

(a) π (b) 2π (c) $\pi/4$ (d) $\pi/2$

4. In a Fraunhoffer diffraction experiment at a single slit using light of wavelength 400 nm, the first minimum is formed at an angle of 30° . Then direction 'θ' of first secondary maximum is given by

(a) $\sin^{-1}(3/4)$ (b) $\tan^{-1}(4/3)$ (c) 60° (d) $\tan^{-1}(3/4)$

5. The limit of resolution of a one metre radio telescope for radio waves of wave length 10 cm is about

(a) 7° (b) few seconds of arc (c) 18° (d) one minute of arc

6. A telescope has an aperture 140 cm. The least angular separation for two stars which can be resolved by the telescope for light of wavelength 5.6×10^{-7} m is

(a) 3.0×10^{-7} radian (b) 4.88×10^{-7} radian (c) 0.25×10^{-7} radian (d) 0.35×10^{-7} radian

7. Two wavelengths λ and $\lambda+\Delta\lambda$ (with $\Delta\lambda \ll \lambda$) are incident on a diffraction grating. Then, the angular separation between the spectral lines in the mth order spectrum is,

(a) $\Delta\theta = \dfrac{\Delta\lambda}{\sqrt{(d/m)^2-\lambda^2}}$ (b) $\Delta\theta = \dfrac{\Delta\lambda}{\sqrt{(m/d)^2-\lambda^2}}$

(c) $\Delta\theta = \dfrac{2\Delta\lambda}{\sqrt{(d/m)^2-\lambda^2}}$ (d) none of these

8. In a double slit experiment with a wavelength of 500 nm, two slits are made one mm apart and the screen is placed one metre away. What should the width of each slit be to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern?

(a) 0.05 mm (b) 0.1 mm (c) 0.2 mm (d) 0.5 mm

9. What is the minimum distance between two points that will permit them to be resolved at 2km using a terrestrial telescope of 6.5×10^{-2}m diameter objective at wavelength of 5500 Å?

(a) 0.023 cm (b) 1.032 cm (c) 1.510 cm (d) 2.065 cm

10. Light of wave length 5893 Å is used in an experiment with a microscope. If the semi vertical angle is 50^0.Calculate the resolving power of the microscope.

(a) $2.6\times10^6 / m$ (b) $3.2\times10^6 / m$ (c) $4.3\times10^6 / m$ (d) $5.3\times10^6 / m$

ANSWER KEYS

1. b	2. c	3. b	4. a	5. a	6. b	7. a	8. c	9.d	10. a

1. The critical angle of certain medium is $\sin^{-1}\left(\frac{3}{5}\right)$. What is the polarizing angle of the medium?

(a) $\tan^{-1}(5/3)$ (b) $\tan^{-1}(3/5)$ (c) $\tan^{-1}(3/4)$ (d) $\tan^{-1}(4/3)$

2. If θ is the polarising angle for two optical media, whose critical angles are C_1 and C_2 , then the correct relation is:

(a) $\sin\theta = \frac{\sin C_2}{\sin C_1}$ (b) $\theta = \frac{\sin C_2}{\sin C_1}$ (c) $\tan\theta = \frac{\sin C_1}{\sin C_2}$ (d) $\sin\theta = \frac{\sin C_1}{\sin C_2}$

3. A Polaroid is being used as an analyzer of plane Polaroid light. In one complete rotation of the crystal, the maximum intensities will be observed only

(a) once (b) twice (c) thrice (d) data is inadequate

4. When light is incident from air to glass at an angle 57^0 , the reflected beam is completely polarized. If the same beam is incident from water to glass, the angle of incidence at which reflected beam is completely polarized will be,

(a) $\theta = 57^0$ (b) $\theta > 57^0$ (c) $\theta < 57^0$ (d) cannot be determined

5. A beam of light strikes a piece of glass at an angle of incidence of 60^0 and the reflected beam is completely plane polarised. The refractive index of the glass is:

(a) 1.5 (b) $\sqrt{3}$ (c) $\sqrt{2}$ (d) $3/2$

6. A Polaroid is placed before an incoming light beam and allows an intensity I_0 through itself. Now the intensity of light passing through the Polaroid after it is rotated by 45^0 would be:

(a) I_0 (b) $I_0/2$ (c) $I_0/4$ (d) zero

7. Two polaroids are kept crossed to each other. Now, one of them is rotated through an angle of 45^0 . The percentage of incident light now transmitted through the system is:

(a) 15% (b) 25% (c) 50% (d) 60%

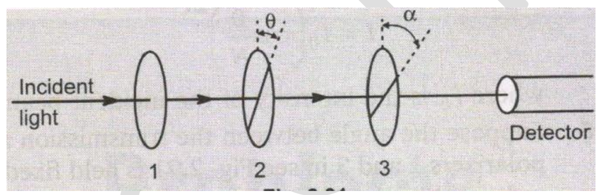
8. A clear sheet of Polaroid is placed on the top of similar sheet so that their axes make an angle $\sin^{-1}(3/5)$ with each other. The ratio of intensity of the emergent light to that of unpolarised incident light is:

(a) 16:25 (b) 9:25 (c) 4:5 (d) 8:25

9. Two polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second Polaroid. If a third Polaroid whose polarization axis makes an angle θ with the polarization axis of first Polaroid, is placed between these polaroids, then the intensity of light emerging from the last Polaroid will be

(a) $\frac{I_0}{8}\sin^2 2\theta$ (b) $\frac{I_0}{4}\sin^2 2\theta$ (c) $\frac{I_0}{2}\cos^4\theta$ (d) $I_0\cos^2\theta$

10. Suppose that the transmission axes of the left and right polarizing discs are perpendicular to each other. Also, let the centre disc be rotated on the common axis with an angular speed ω. If unpolarized light is incident on the left disc with an intensity $I_{\max}$, the intensity of the beam emerging from the right disc is,



(a) $I = \frac{I_{\max}}{16}(1-\cos 2\omega t)$

(b) $I = \frac{I_{\max}}{16}(1-\cos 4\omega t)$

(c) $I = \frac{I_{\max}}{8}(1-\sin 2\omega t)$

(d) $I = \frac{I_{\max}}{8}(1-\sin 4\omega t)$

ANSWER KEYS

1. a	2. c	3. b	4. c	5. b	6. a	7. b	8. d	9.a	10. b